MEA-1500SL

OPERATING INSTRUCTIONS

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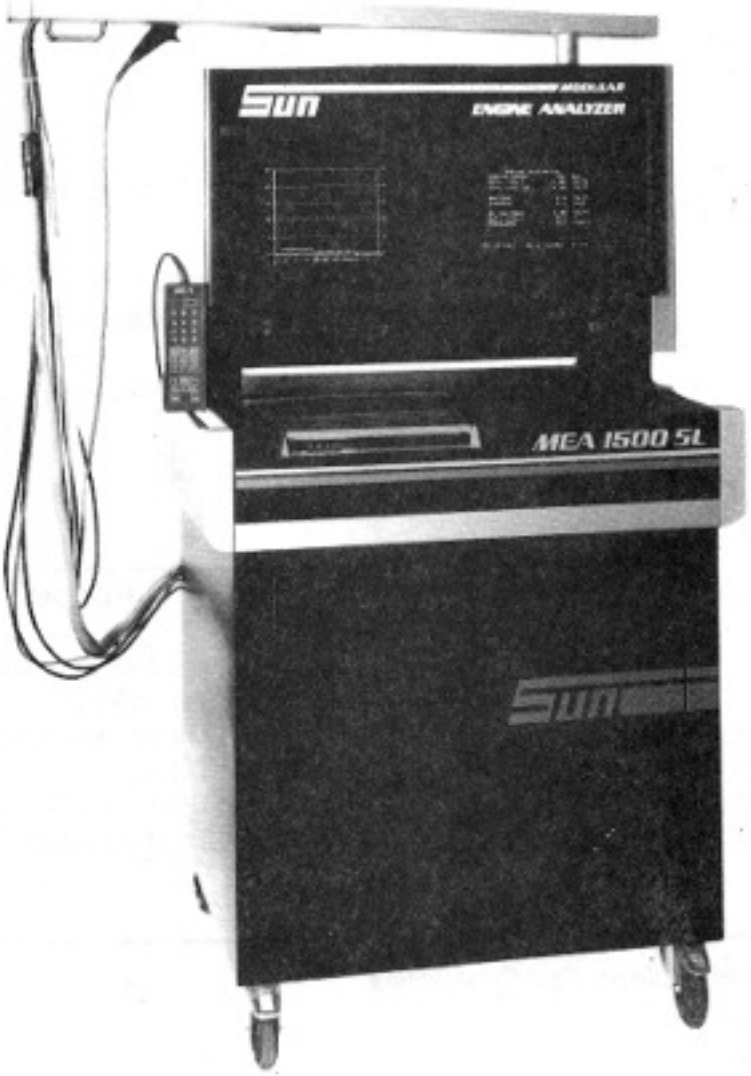


FIGURE 1. MODEL MEA-1500 SL with test stand and printer

INTRODUCTION

GENERAL INFORMATION

The modular engine analyzer, Model MEA-1500 SL, shown in Figure 1, displays test data for the detection of abnormal operating conditions in gasoline internal-combustion engines. It is microprocessor-controlled and electronically self-calibrating. Testing is accomplished through:

* a 12 inch oscilloscope ("scope") that displays ignition, alternator and electronic systems signal waveforms.

* a 12 inch video display unit (VDU) that displays digital test data and plain language instructional messages which provide assistance in operating the tester.

* a remote control that permits operation of both the VDU and scope from behind the wheel or under the hood.

The analyzer's standard and optional test capabilities and hardware are shown in Figures 2 and 3. The MEA-1500 SL Operator's Manual presents illustrated instructions for operating the engine analyzer with all options installed.
Refer to "Accessories" for a complete listing with part numbers of standard and optional accessories.

MEA-1500 SL Test Capabilities

STANDARD	OPTIONAL
* RPM	* HC,CO,CO_2,O_2 emission module
* Dwell	* Amps/Vacuum
* Strobe Timing	* Oil temperature
* Battery & Distributor volt	* Diesel
* Scope volt/kilovolt/millisec	* SUN Data Link communication
* Pinpoint volt/ohm	* Lambda and AFR
* Frequency	
* Duty cycle	

FIGURE 2. Standard and Optional Test Capabilities.

MEA-1500 SL Hardware

STANDARD	OPTIONAL
* Analyzer console	* Industry-standard printer
* Remote control	* 4 Gas analyzer
* Test-lead boom	* Amps/Vacuum kit
* Leads, connector	* Oil temperature kit
* Adaptor set	* SUN Data Link communication
	* Diesel test kit

FIGURE 3. Standard and Optional Analyzer Hardware.

Safety Precautions

The following precautions must always be observed when doing automotive testing.

1. Exhaust gases contain carbon monoxide which is a colorless and odorless lethal gas. Always work in properly ventilated areas.

2. Gasoline fumes are explosive. Do not smoke around gasoline.

3. Wipe up gasoline spills immediately and dispose of soaked rags in proper air-tight containers. Always stop leaks and clean spills immediately.

4. Check the engine oil level and add oil if necessary before testing.
A vehicle should not be tested if it is low on oil.

5. Check the coolant level before testing. A vehicle should not be tested if it is low on coolant. If the engine is hot, check the level of the overflow tank.

   CAUTION: Do not open closed coolant systems while the fluid is hot.

6. Do not wear loose clothing or a necktie near an operating engine.
Keep hands and hair away from moving engine parts such as fan blades, belts or pulleys.

7. Be particularly careful not to operate the timing light too near fans or belts. The timing light may have the effect of making the fan seem to "stand still". This is a dangerous optical illusion which might cause the operator to contact the fan.

8. Safety goggles should be used when working on a vehicle to protect eyes from acid, dust, gasoline, or objects which may fly off moving parts.

9. Never look directly into the carburetor throat when cranking or running the engine. Backfiring may cause burns.

10. Never wear wrist watches, rings, or other jewellery when working on a vehicle. Such items may catch on moving parts or cause electrical short circuits, burning the wearer.

11. Avoid contact with hot surfaces such as exhaust manifolds and pipes, mufflers, catalytic converters or radiators and hoses.

12. Do not lay tools or equipment on the battery. Accidental grounding of the battery terminals may cause shocks or burns, damage wiring, or damage the battery itself. Battery acid can damage clothing and burn skin or eyes. If you contact battery acid, wash with as much water as possible and use weak soda(such as baking soda) to neutralize the acid. If acid enters your eyes, see a doctor as soon as possible.

13. A fire extinguisher should always be kept in the work area. The extinguisher should be suitable for a range of uses including gasoline, chemical and electrical fire.

14. High voltage is present in the secondary side of the ignition system. Always use insulated pliers when handling ignition system components while the engine is running.

15. Hydrogen gas is produced by automotive batteries. Flame or sparks near the battery may cause it to explode.

16. Place wheel chocks in front of and at the rear of the drive wheels before testing a vehicle.

OVERVIEW

Operator VDU messages

With the exception of the oscilloscope, the MEA-1500 SL operates entirely through individual display screens, called "pages", which appear on the Video Display Unit, commonly referred to as a VDU. A "menu" page contains a list of options from which the operator is prompted to make selections.

To make menu selections, and to advance from page to page, the operator follows the prompt messages which appear on the VDU. Prompt messages usually ask the operator to make remote control entries. If a specific key should be pressed to complete a required action, the key's symbol will be highlighted in reverse video on the VDU. This means the key symbol will be contrasted in black against a bright green VDU background.

Status indicators are another type of operator message, which indicate the state of tester settings, controls and hook-ups. Some status indicators will flash on the VDU when the operator's immediate attention is required. For example, the TRIGGER PICKUP NOT SENSED message flashes on the POWER BALANCE page if the trigger pickup is not connected properly.

"Help" messages are supplementary pages which tell the operator how to perform a specific task. They contain information on: 1) analyzer set-up, 2) vehicle set-up, 3) analyzer operation and 4) vehicle connections. The help messages (which explain the tasks related to an individual page) are available by pressing the ? key, on the remote control, when the page is displayed.

Typical example of a specific help page.

1. IF PRINTER OPTION IS FITTED
   CHECK PAPER SUPPLY AND ALIGN
   PAPER PERFORATION WITH PRINTER
   PAPER CUTTER. WHEN A PAPER
   ADVANCE (FORMFEED) IS DESIRED
   QUICKLY PRESS ◁ TWICE.
2. IF EMISSIONS OPTION IS FITTED
   CHECK EMISSIONS FILTERS
3. A 15 MINUTE WARM-UP IS
   REQUIRED FOR EMISSIONS READING
   WHEN WARM UP IS COMPLETE
   PRESS ↵ TO CONTINUE.
4. TO USE TESTER WITHOUT EMISSIONS
   PRESS ↵

FOR MORE HELP PRESS ?
TO RETURN TO PROGRAM, PRESS ↵

FIGURE 4. Shows a help message which can be accessed from the CALIBRATION page and explains what the operator needs to know to successfully complete calibration. Note the prompt message at the bottom of the page with key in reverse video.

Program Menu

The analyzer's primary menu is the PROGRAM MENU page (Figure 5), which contains four or five options. Brief descriptions of each option's purpose and principal features appear in the following paragraphs.

The PROGRAM MENU page can be reached at any time by pressing the P key once or twice, depending on where you are in the program. To select an option on the PROGRAM MENU, press the key number corresponding to the menu selection on the remote control.

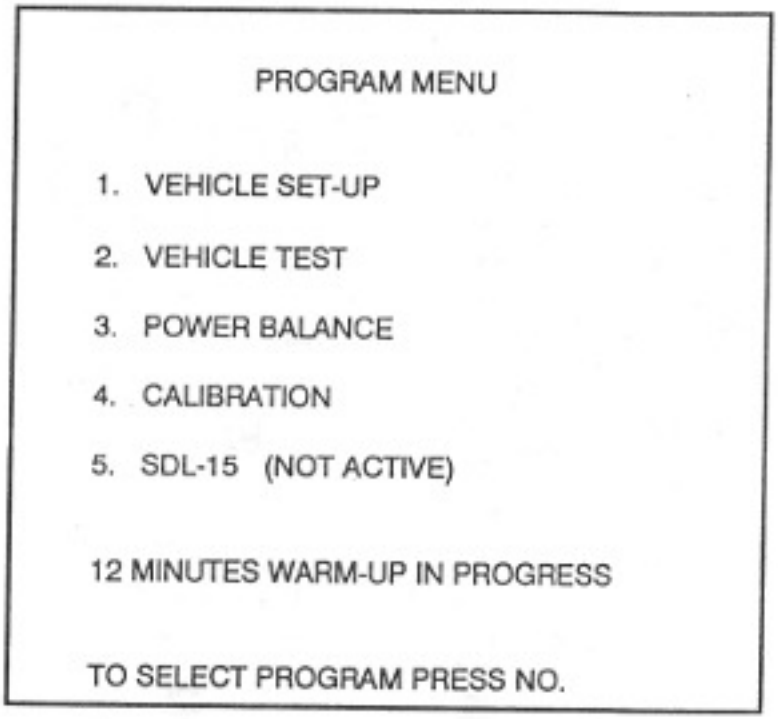


FIGURE 5. Shows the Program Menu from which the operator selects the desired analyzer function.

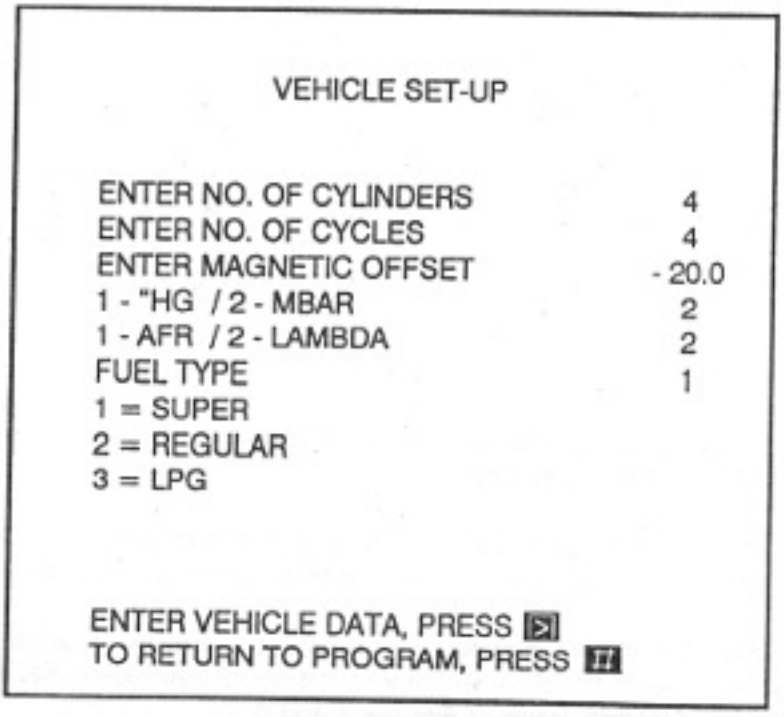
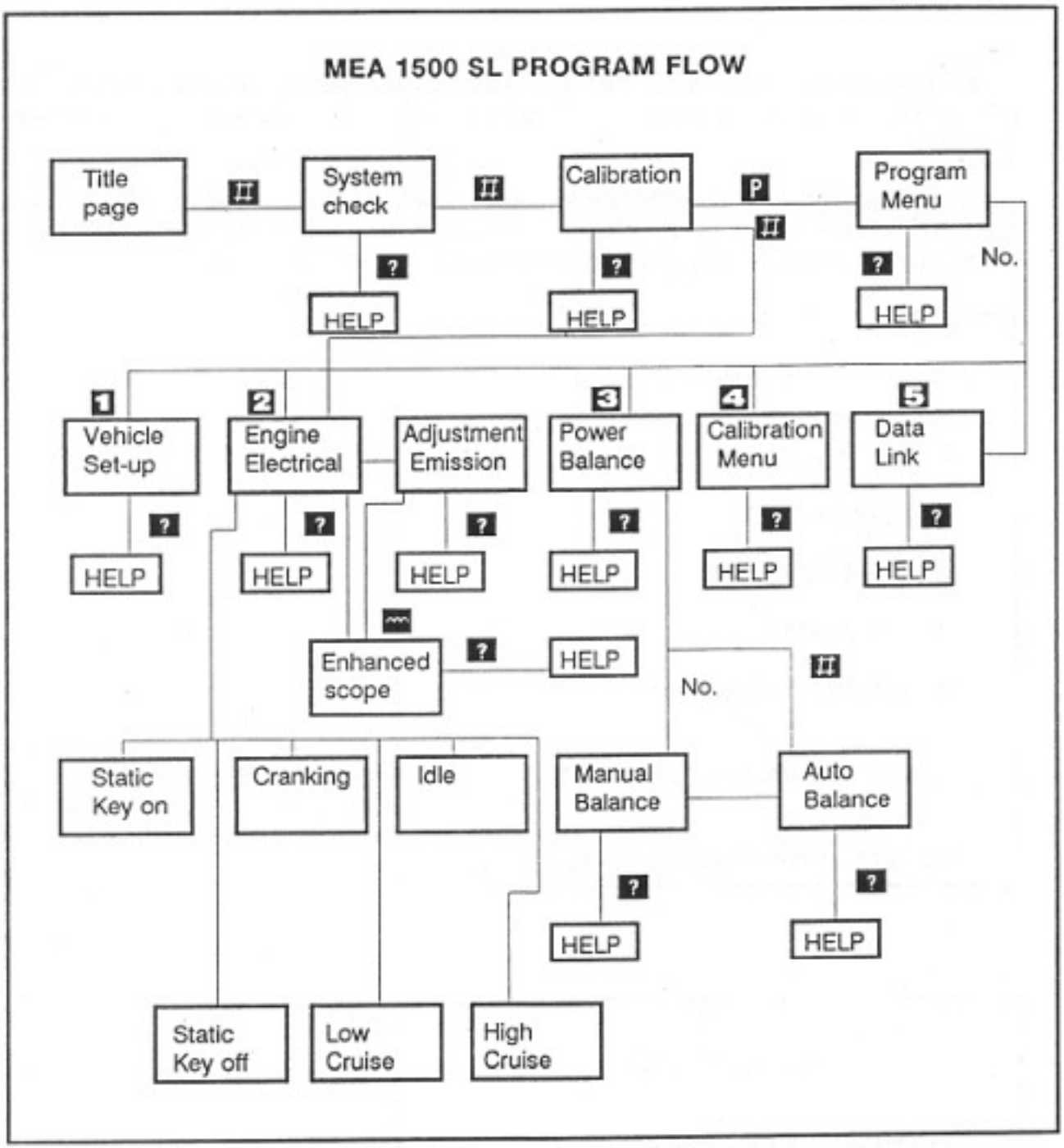


FIGURE 6. The MEA-1500 SL is pre-set for the most common four-cylinder vehicles. Help messages detail how to change the setting if needed.



Program Flow of the MEA-1500 SL (incl. optionals)

SELECTION #1: Vehicle Set-up

The VEHICLE SET-UP page (Figure 6) is used to set four vehicle specifications: no. of cylinders, no. of cycles, magnetic offset angle and fuel type.

Upon the analyzer power-up, the vehicle set-up page is preset for 4-cylinders, 4-cycles, a magnetic offset angle of - 20.0 degrees, mBar for vacuum measurement, Lambda and Super.

The analyzer accepts 2, 3, 4, 5, 6, 8 and 12 cylinders, two and four cycles, and magnetic offset angles of between 0 and - 359.9 degrees. The mag. offset angle and the no. of cylinders selected appear at the bottom of the VEHICLE TEST pages. Refer to Figures 7 and 8.

If the vehicle being tested is equipped with built-in magnetic timing sensors, the magnetic offset angle will automatically be adjusted, and will override any preset angles. This usually applies to European vehicles only and the angle will be preset to - 20.0 or 0.0 degrees.

The vacuum is preset to display values in millibar (mBar). It is possible to change this to display vacuum reading in inches of mercury ("Hg) by pressing the corresponding number.
(1 = "Hg/ 2 = mBar).

The adjustment of the carburetor is easily checked using the Lambda or the Air-Fuel Ratio measurement. (1 = AFR / 2 = Lambda)

For the Lambda measurement it is necessary to specify the type of fuel the engine is using. The operator can make a selection from 3 types of fuel.
(1 = Super RON 98/95, 2 = Regular RON 91, 3 = LPG).

The operator can quickly advance to the VEHICLE SET-UP page from any other page by pressing the key, and return to the original page by pressing the key. Refer to "Test preparation" and "Controls" for data entry instructions.

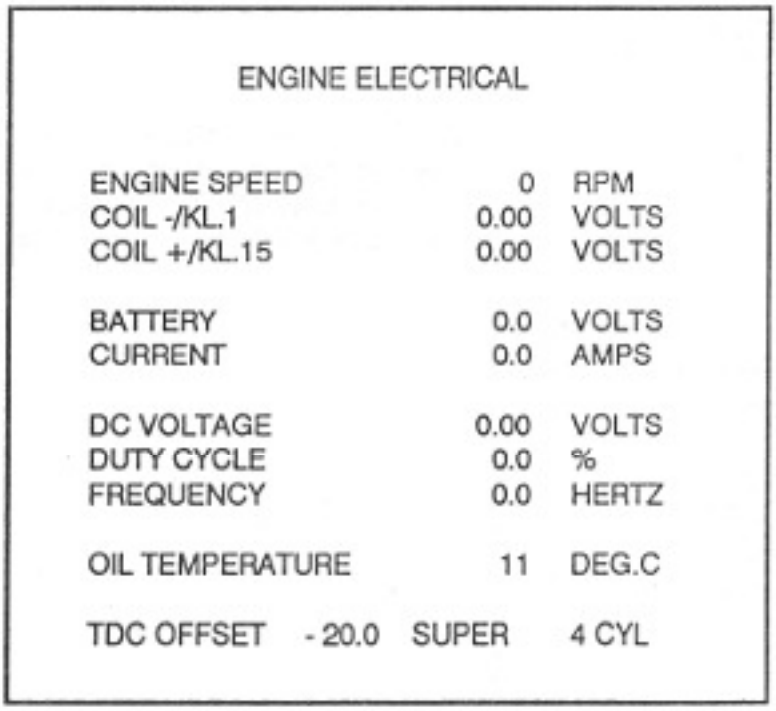


FIGURE 7. Help messages that detail how to hook-up the vehicle for testing can be reached from this page.

SELECTION # 2: Vehicle Test

The VEHICLE TEST page exists of two separate pages. The VEHICLE ELECTRICAL page (Figure 7) is used to perform key-on and key-off tests, cranking tests, loading tests and pinpoint tests. The ADJUSTMENTS/EMISSIONS page (Figure 8) can be entered by pressing the key in the VEHICLE ELECTRICAL page and is used to perform idle tests, adjustment tests and pinpoint tests. Refer to "Test procedures" for instructions.

Standard test measurements include engine speed, dwell/distributor volts, duty cycle, frequency, strobe timing, DC voltage/ohms and battery voltage. Dwell is measured in both degrees and percent. When RPM is 0, the dwell reading on the VDU changes to DIST. VOLTS (distributor volts) for

checking distributor resistance under static conditions. For pinpoint tests, the DC voltage reading may switched to ohms (and back to volts) by pressing the VOLT/OHM key successively.

Optional test measurements include amps, magnetic timing, vacuum, temperature, Lambda or AFR, HC, CO, CO_2, O_2 and HC per cylinder. If the magnetic timing probe is used, the strobe timing line automatically switches to mag. timing on the VDU. If an option is not installed, NOT ACTIVE will appear next to the test parameter.

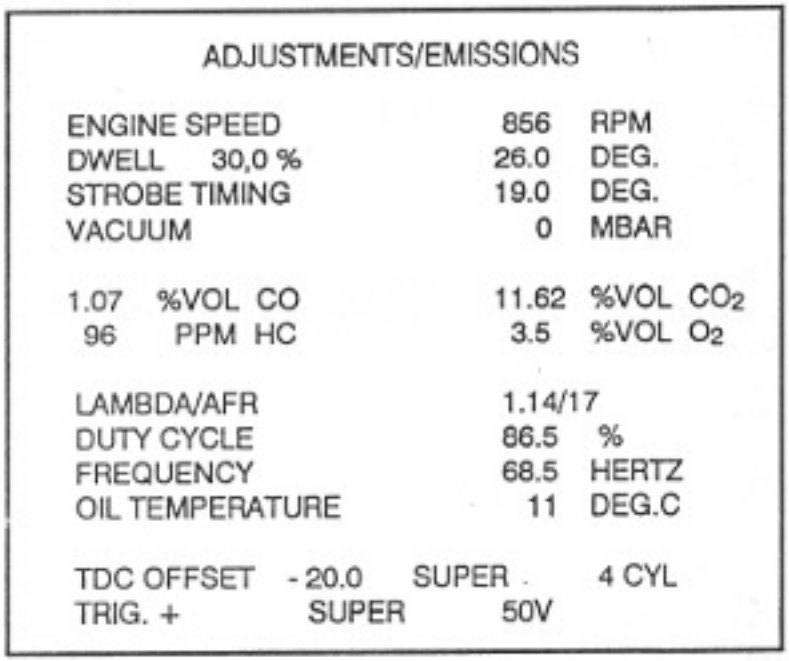


FIGURE 8. Help messages that detail how to hookup the vehicle for testing can be reached from this page. Lambda or AFR are on the same line.

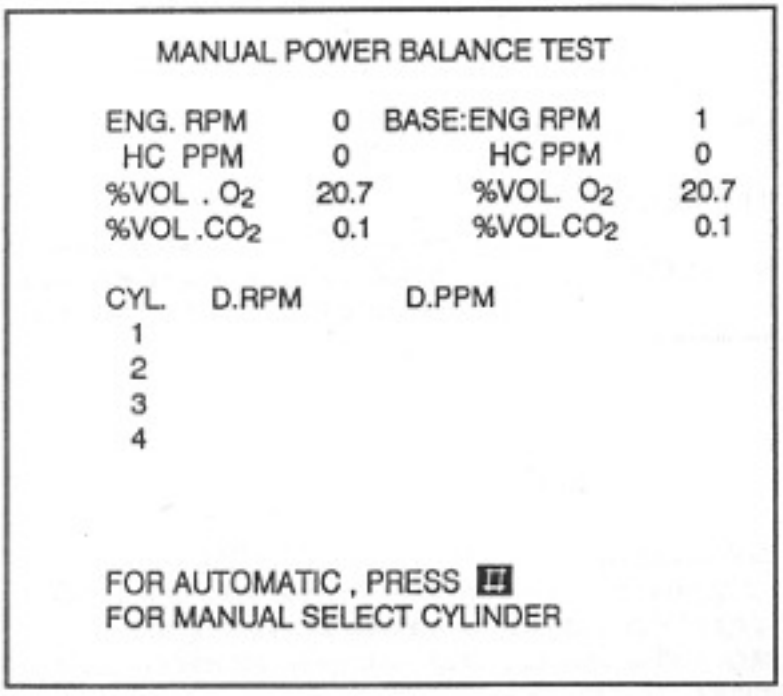


FIGURE 9. This page has help messages that detail how to prepare the vehicle for power balance tests and how to preform them. The HC measurement has a range of 5000 ppm HC during the power balance test.

Selection #3: Power Balance

The POWER BALANCE TEST page (Figure 9) is used to perform either an automatic power balance or a manual power balance. In the automatic power balance, each cylinder is shorted out automatically in firing order sequence and an individual RPM CHANGE and HC RANGE readings are displayed.(if an emissions module is installed)

In the manual power balance, cylinders may be selectively shorted out while displaying corresponding RPM changes. The RPM change displayed is the difference between the displayed BASE RPM reading and the actual reading.

When the emissions option is installed the HC changes will be displayed during automatic power balance. The HC change is the difference between the displayed BASE ppm HC and the highest HC reading while a cylinder is shorted out.(This measurement is available with program version V 3.16 or higher).

When the program level is lower than V 3.16 the readings of vacuum and CO, HC, O_2 will appear during manual power balance tests. The changes in these measurements may be observed when individual cylinders are shorted out. Refer to "Test Procedures" for power balance instructions.

Selection #4: Perform Calibration

One of the two pages will appear when this menu selection is made.

a. If an emissions module **is not** installed, the CALIBRATION page(Figure 10)identical to the one that appears after the tester self-test/warm-up page, will be displayed. Refer to "Test Preparation" for instructions on how to automatically self-calibrate the analyzer.

b. If the emissions module is installed, a CALIBRATION MENU page(Figure 11) will be displayed. The menu contains a selection of gas calibration or the above mentioned system calibration.(press 1 or 2 for selection)
Refer to "Maintenance and Service" for details on gas calibration.

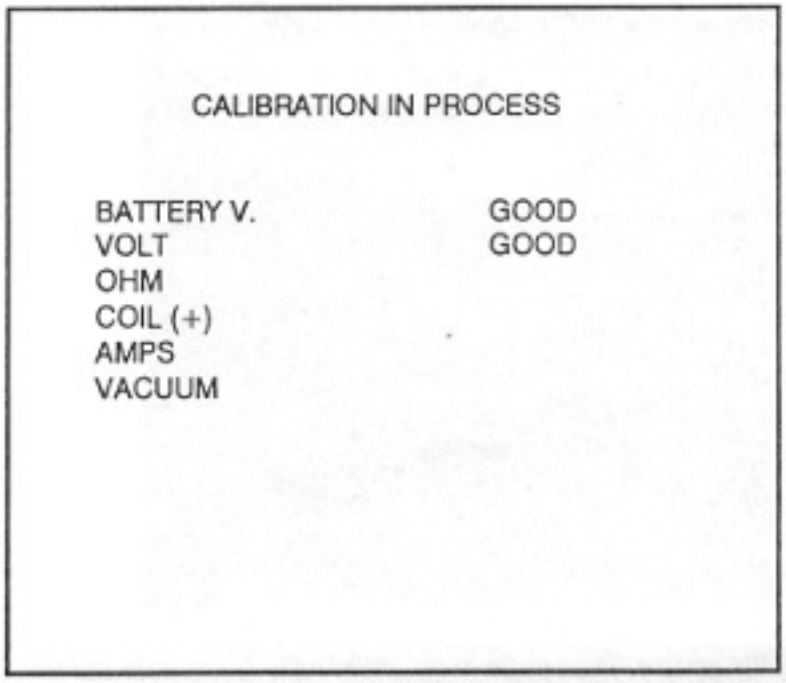


*FIGURE 10. If an emissions module **is not** installed, this page appears when selection four is made on the PROGRAM MENU page.*

CALIBRATION MENU

1. SYSTEM CALIBRATION

2. MANUAL GAS CALIBRATION

TO SELECT PROGRAM, PRESS NO.
TO RETURN , PRESS ⏎

FIGURE 11. If an emissions module is in stalled, this page appears when selection four is made on the PROGRAM MENU page.

Oscilloscope

The scope (Figure 12) is capable of displaying primary and secondary circuit patterns, in display, raster and superimposed modes of waveform display. A five millisecond time sweep and a special waveform mode to display electronic systems signals, may also be selected.

When the scope is in the display mode, individual cylinder waveform(s) may be expanded and positioned at the millisecond scale line by pressing the cylinder's corresponding key number.

With the exception of front-panel adjustment controls for scope brightness, position, and spacing, the scope is operated entirely with the remote control. Anytime a scope control key is pressed, the setting will appear for a short time in reverse video at the bottom of the VDU (Figure 13).

Refer to "Instruments and Controls" and "Test Procedures" for detailed information on scope operation and testing.

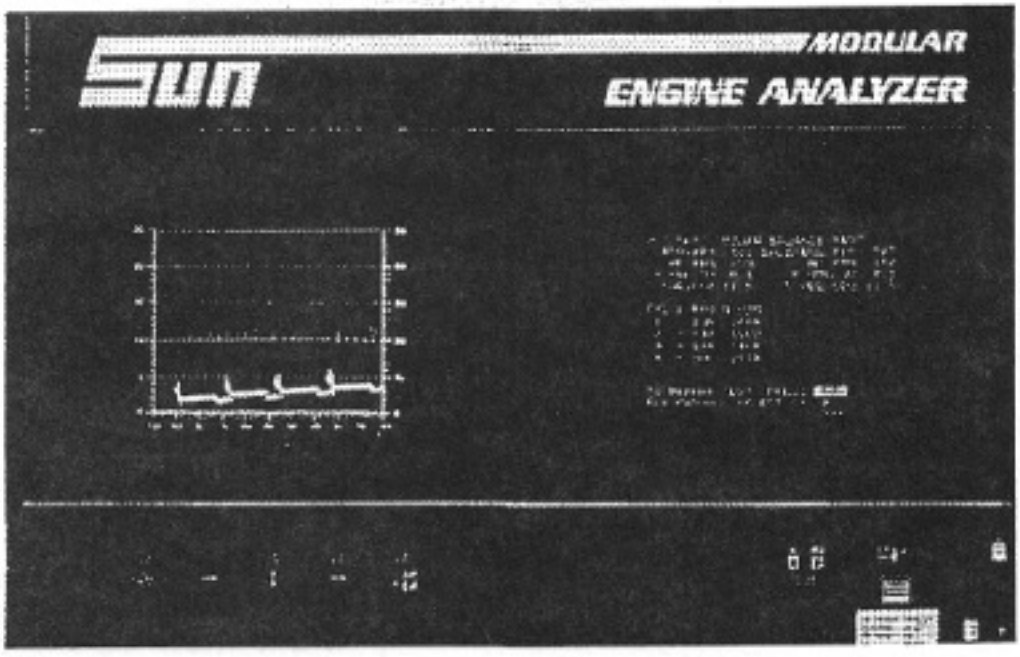


FIGURE 12. Shows a display pattern on the scope. The scope is operated with the remote control.

ADJUSTMENTS/EMISSIONS

ENGINE SPEED			856	RPM
DWELL	30.0	%	26.0	DEG.
STROBE TIMING			19.0	DEG.
VACUUM			0	MBAR
1.07	%VOL	CO	11.62	%VOL CO_2
96	PPM	HC	3.5	%VOL O_2
LAMBDA/AFR			1.14/17	
DUTY CYCLE			86.5	%
FREQUENCY			68.5	HERTZ
OIL TEMPERATURE			60	DEG.C

TDC OFFSET -20.0 SUPER 4 CYL
TRIG. + SUPER 50 V

FIGURE 13. Scope settings appear in reverse video at the bottom of the VDU.

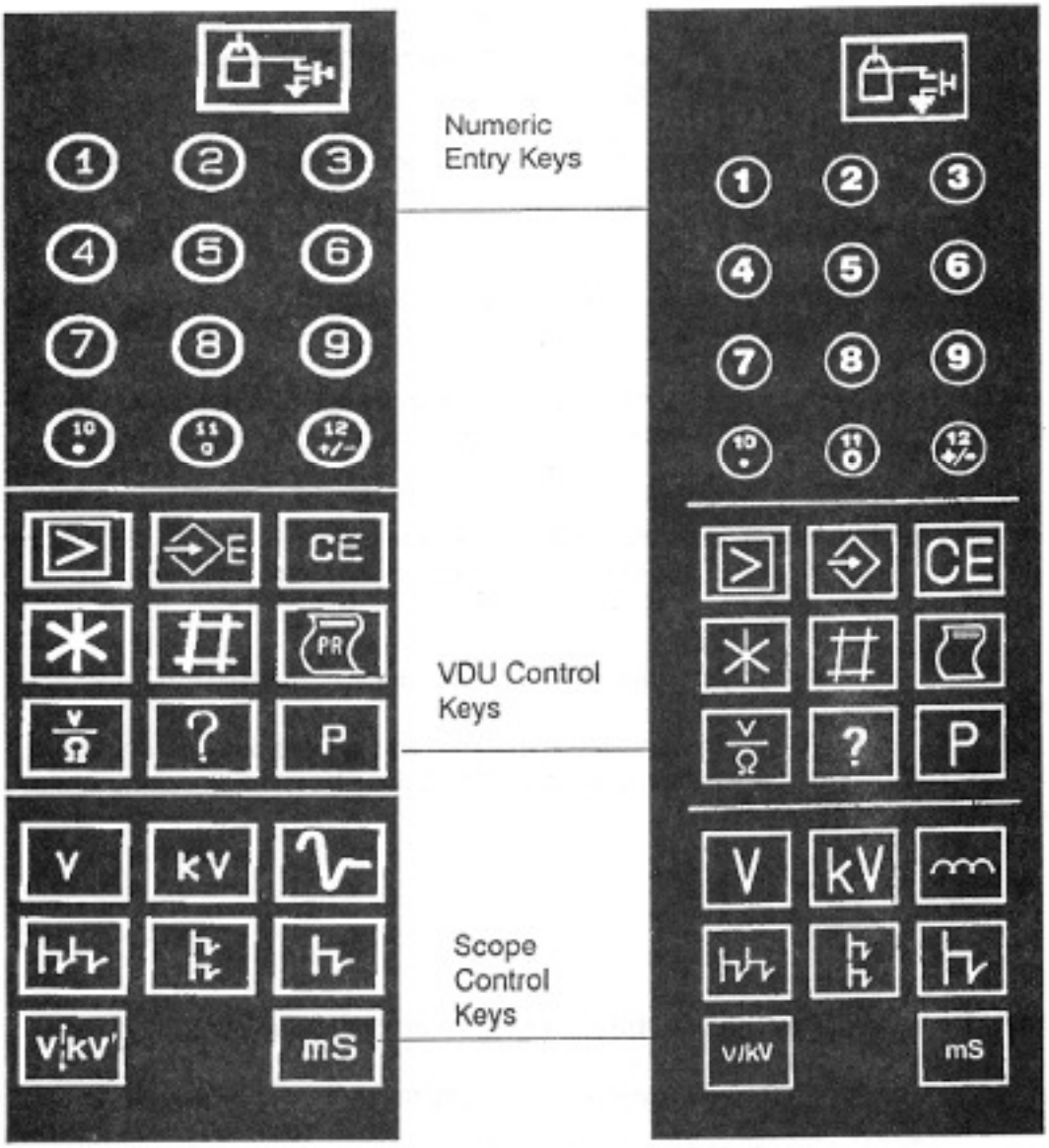


FIGURE 14. Remote controls "OLD" and "NEW" type.

CONTROLS

Remote Control

The remote control keypad is divided into three basic sections: numeric entry, VDU control, and scope control. An engine kill key is located in the upper right hand corner of the remote control.

ENGINE KILL - press to electronically disable the engine (i.e. to stop the engine in emergency situations or to perform cranking tests).
Press the key again to release the ENGINE KILL. When ENGINE KILL is on, a status indicator will be displayed on the VDU.

Numeric Entry Keys

Numeric entry keys are used to make menu selections, enter numerical data, and to select a specific cylinder (i.e. for power balance or scope display).
The function of the key depends on the page displayed. For example, a numeric key pressed on the power balance page will short out a cylinder. On the VEHICLE TEST page, a numeric key pressed will select a cylinder for expanded view on the scope.

NOTE: The ten (10), eleven (11) and twelve (12) functions cannot be used in the vehicle Set-up page. For example, a number of cylinder entry for a 12 cylinder engine accomplished by pressing the "1" then "2".

1–9 Press these keys to make number entries and select cylinders.

10 . Dual function: Press ten (10) to select the number (i.e. cylinder selection on scope control or power balance page). Use the decimal point (.) with numeric entry keys on the data entry pages.

11 0 Dual function: Press eleven (11) to select the number (i.e. cylinder selection on scope control or power balance page). Use the zero (0) with numeric entry keys on the data entry pages.

12 +/- Dual function: Press twelve (12) to select the number (i.e. cylinder selection on scope control or power balance page).
Select the plus or minus (+/-) function by pressing this key successively when required on the VEHICLE SET-UP number entries, and on the Lab scope to select the rising or the falling edge of the trigger signal.

VDU Keys

VDU keys are used to select or change VDU pages and to clear, print or freeze VDU data.

Dual function. Press this key on the data entry page to move the cursor (>) down the page to the next data entry line.
Press this key in the VEHICLE TEST to toggle between the ENGINE ELECTRICAL page and the ADJUSTMENTS/EMISSIONS page.

Press this key to advance directly to the Vehicle Set-up page from any other page.

CE Press this key to ERASE data prior to repeating tests or to clear a data entry field.

Press this key to stop the automatic update of data on the ENGINE ELECTRICAL and ADJUSTMENTS/EMISSIONS pages and "freeze" the data for analysis. Pressing a second time reactivates the screen and discontinues the status indicator on the VDU.

Press the continue key when prompted. It is typically used to leave a test page, start a test or, to return from HELP or VEHICLE SET-UP pages.

Dual function:

1) To print out any individual data page, press the key ONCE. There will be momentary pause before the printer begins to print out the information which appears on the VDU page, except the prompt messages at the bottom.

2) To form feed the printer to the next top of form (perforation), press this key TWICE in rapid succession. Refer to the printer operation section for instructions on setting the top of form.

Press this key successively to change the display of VOLTS to OHMS and back again on the ENGINE ELECTRICAL page.

? Press this key for help in setting up the vehicle, setting up the tester or operating the tester. Refer to the "Overview" for more detail.

P Press this key to return to the previous MENU page.

Scope Keys

The scope control keys are used to select the type of waveform display and the scale to be read. Once selected, these settings are displayed for a short period of time at the bottom of the VDU.

NOTE: Upon power-up, the scope is automatically pre-set to display a PRIMARY circuit waveform in a horizontal row (PARADE) and high scale range.

V Press this key to display a PRIMARY circuit waveform on the scope.

kV Press this key to display a SECONDARY circuit waveform on the scope.

Dual function; Press this key ONCE to display an ALTERNATOR output waveform on the scope (signalled from the Red battery(+)lead). Press this key once again to display various waveforms on the scope (signalled from the VOLT/OHM leads). Press the V or kV key to display PRIMARY or SECONDARY waveforms.

Press this key to display all the waveforms in a horizontal row (PARADE) across the scope. The number one cylinder *spark* line is displayed at the left of the scope with the remainder of the cylinder waveforms in firing order sequence from left to right, ending with the *firing* line of the number one cylinder on the right.

Figures 15 and 16 show examples of these waveforms.

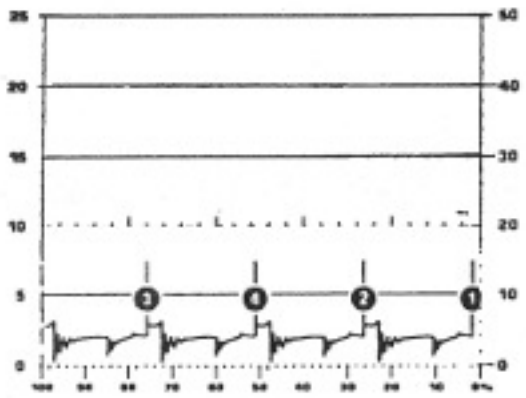


FIGURE 15. Secondary Parade Pattern (Engine firing order 1-3-4-2).

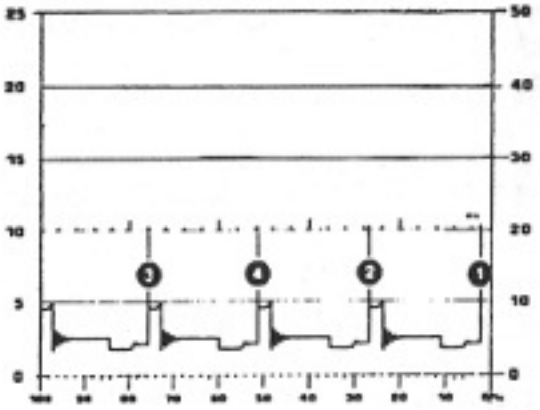


FIGURE 16. Primary Parade Pattern (Engine firing order 1-3-4-2).

Cylinder Select

In the mode, the operator may press a cylinder's number on the remote control and display that cylinder in an expanded sweep above the other cylinders. The cylinder selected will be increased in size and appears in the center of the scope. Pressing the selected keypad number again returns that cylinder's waveform back into the original firing sequence.

One or more cylinders at a time can be selected. Patterns are then overlayed, similar to SUPERIMPOSED. Pressing the key cancels the cylinders chosen and return the waveforms to the original firing sequence. Figures 17 and 18 show examples of secondary and primary waveforms with cylinders selected.

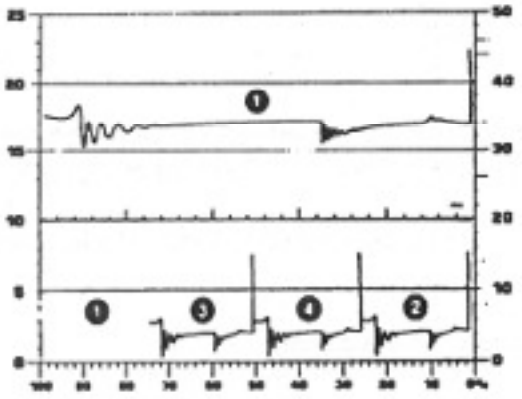


FIGURE 17. Secondary Parade Pattern with Cylinder No. 1 selected. (Engine firing order 1-3-4-2).

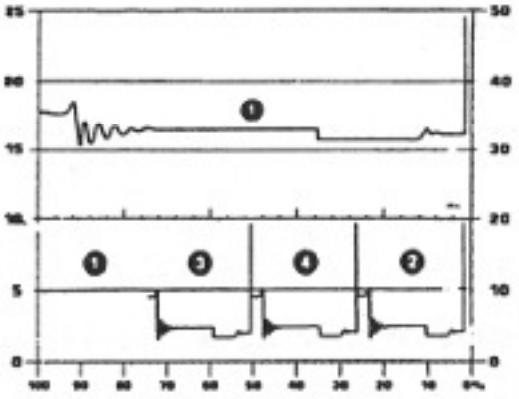


FIGURE 18. Primary Parade Pattern with Cylinder No. 1 selected. (Engine firing order 1-3-4-2).

Press this key to display each cylinder waveform one above the other at full screen width. A RASTER display consists of the cylinder number one waveform displayed at the bottom of the scope with the other waveforms displayed one above the other in firing order sequence. By pressing the appropriate key on the remote, a secondary or primary RASTER waveform may be viewed on the scope.Figures 19 and 20 show examples of these waveforms.

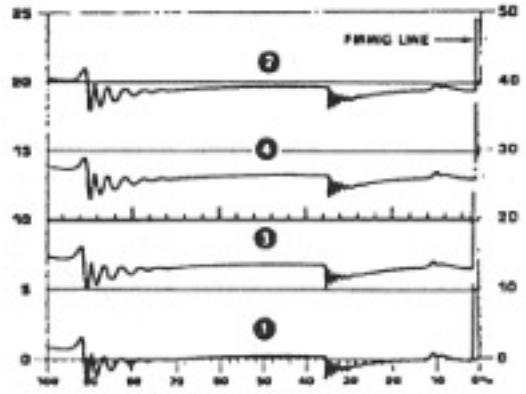


FIGURE 19. Secondary Raster Pattern.

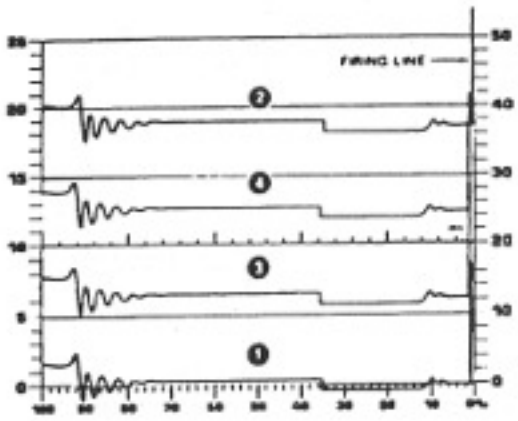


FIGURE 20. Primary Raster Pattern.

The raster spacing control on the front panel (see "Controls") can be used to change spacing between individual cylinders. Individual cylinder select is not available in this mode.

Press this key to display a SUPERIMPOSED pattern, which places all the cylinder waveforms one top of the other. By pressing the appropriate key, a secondary or primary SUPERIMPOSED pattern may be viewed on the scope. Figure 21 and 22 show examples of these patterns.

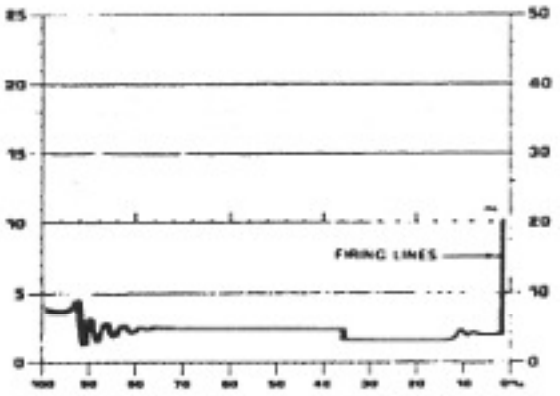


FIGURE 21. Primary Superimposed Pattern.

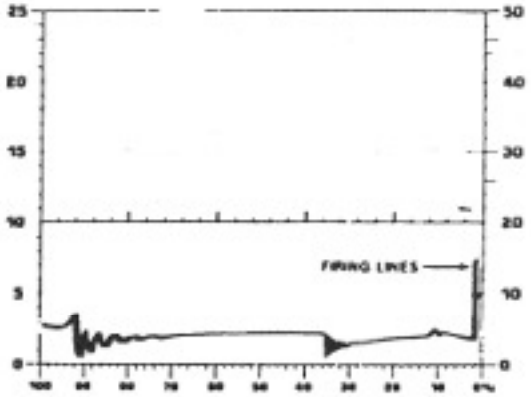


FIGURE 22. Secondary Superimposed Pattern.

Pressing this key once in the mode displays an alternator output pattern on the scope. Figure 23 shows an example of this waveform. Press this key once again and the Lab scope will be displayed.This Lab scope function is used to display Electronic Systems signals. Figure 24 and 25 show examples of these waveforms.

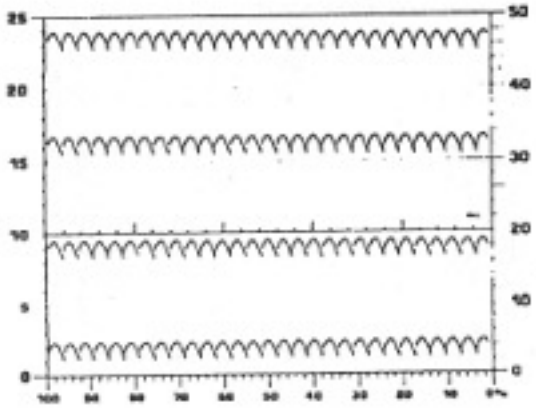


FIGURE 23. Alternator Raster Pattern.

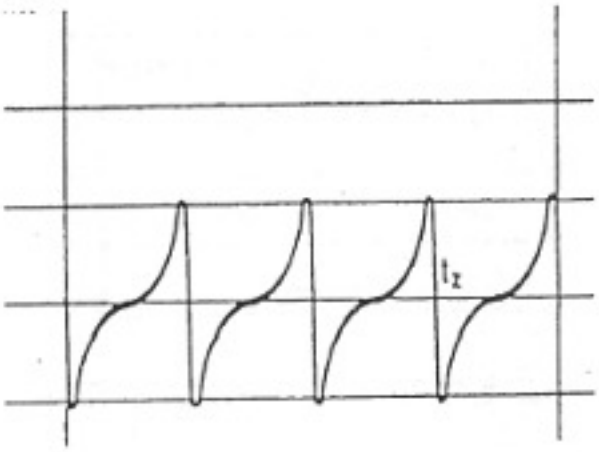


FIGURE 24. Inductive Sensor Signal.

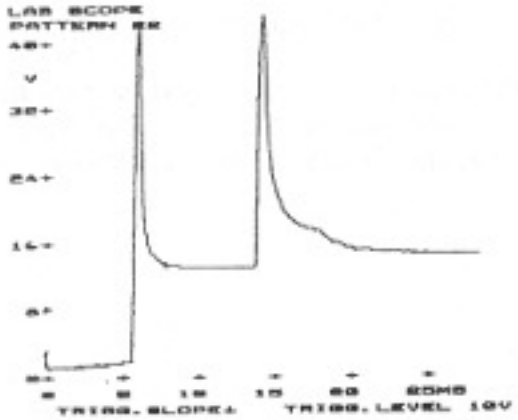


FIGURE 25. Injection Pattern.'

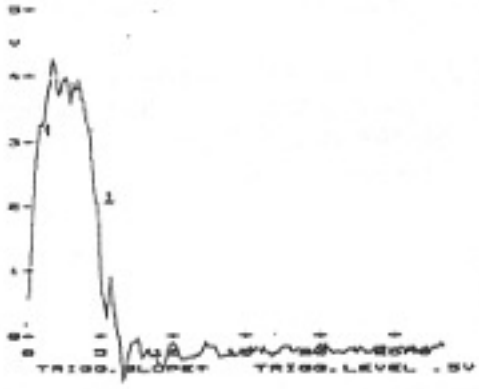


FIGURE 25 a. Diesel pressure waveform pattern.

Scope Scale Keys

The scale selections made will appear for a short time in reverse Video on the VDU.

mS Dual function. Press this key to display the first five milliseconds of the PRIMARY or SECONDARY circuit waveform. Press this key successively to change the horizontal sweep time scale to 5 mS, 25 mS, 100 mS or 100% dwell scale when the Lab scope mode is selected (signalled from the VOLT/OHM leads)

In [1] mode, the cylinder select feature is used with the 5 MSEC sweep to show the first five milliseconds of the selected cylinder. Refer to Figure 26 for an example. In RASTER and SUPERIMPOSED modes, all cylinders will be displayed with the five millisecond sweep rate.

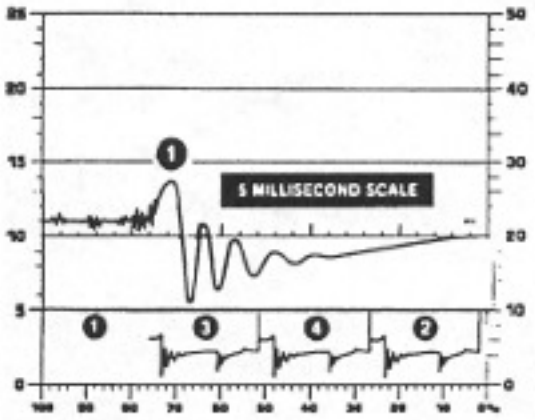


FIGURE 26. 5 mSec Sweep with Cylinder No 1 selected in Parade mode.

V/kV Triple function. Press this key successively to change the vertical scale. PRIMARY circuit waveforms are displayed in either 0 to 500 volts using the right scale, or 0 to 25 volts using the left scale.

V/kV SECONDARY circuit waveforms are displayed in either 0 to 50 kilovolts using the right scale, or 0 to 25 kilovolts scale using the left scale.

LAB SCOPE waveforms signalled from the VOLT/OHM leads are displayed in either 0 to 50 volts using the right scale, 0 to 25 volts using the left scale, or 0 to 5 volts using the right scale.To select the correct trigger polarity press the [12] key to change the trigger polarity. Refer to Lab scope for detailed information on how to use the [12] key.

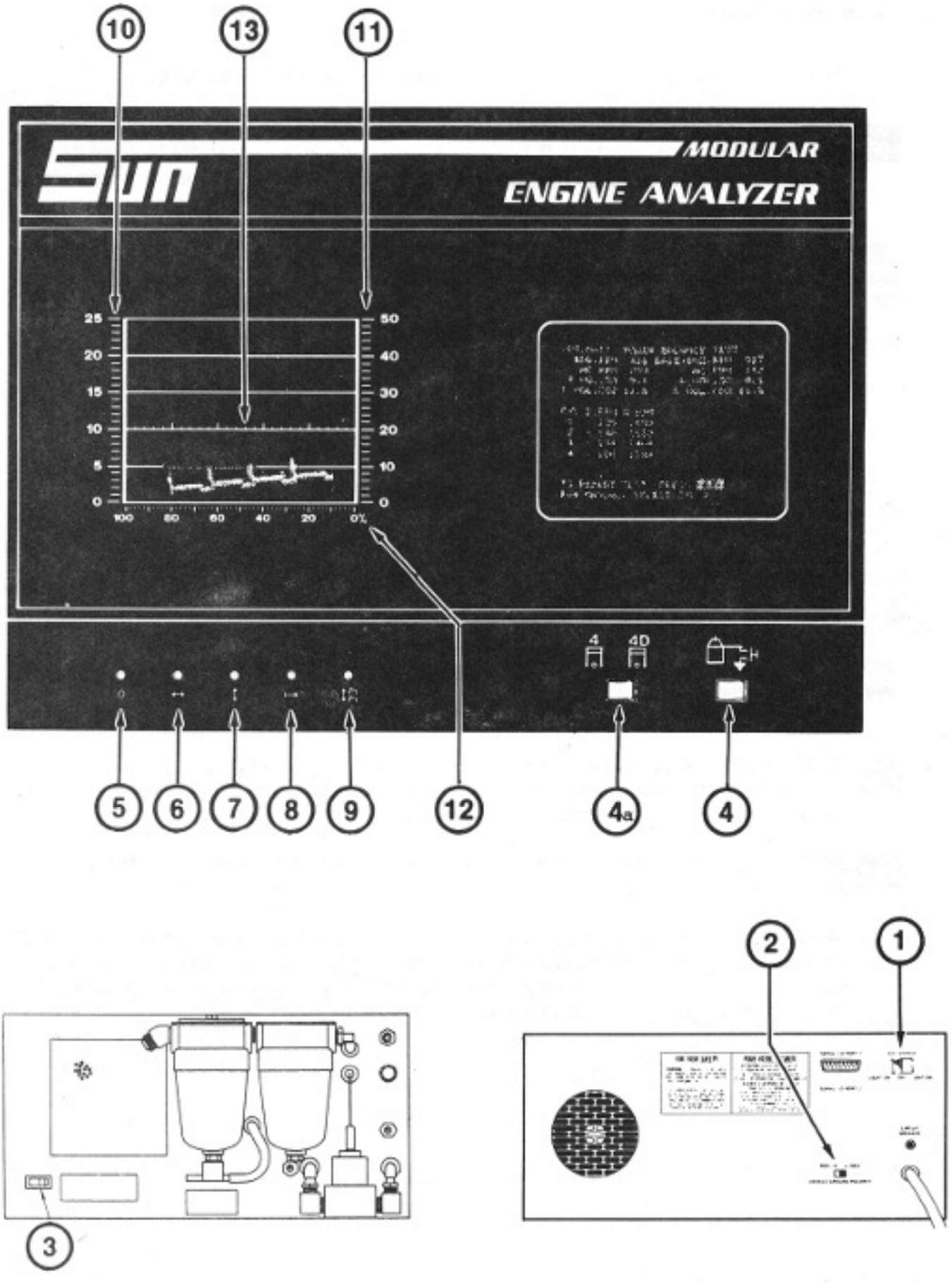


FIGURE 27. Tester-Mounted Controles and Scales.

FRONT-REAR PANEL CONTROLS and SCALES (Figure 27)

Operational

Basic operational controls on the front and rear of the unit include:

Rear

1. ON/OFF SWITCH - Two position switch (Tester ON - Tester OFF) on tester rear panel is used to power the tester and turn the head sign light on.

2. VEHICLE GROUND POLARITY SWITCH - Two position switch (Negative Ground/Positive Ground) located on the rear panel. Be sure the switch is in the proper position before testing ("positive" for positive ground systems and "negative" for negative ground systems). Most vehicles are negative ground.

3. PUMP - Two position switch (Operate/Gas calibrate) on rear panel of gas analyzer. Turn this switch to OPERATE when testing with the optional emissions package to extend pump and filter life. Turn off when not in use.(Versions up till V 6.00 only)
For version V 6.10 and onwards, the computer program will overrule the switch position. When an emissions test is selected the pump will automatically turn on. In the MENU mode, the pump will turn off.

Front

4.  Momentary switch on analyzer front panel duplicates the engine kill function on the remote control. Both engine kills, switch and key can be used together, so if the engine kill is switched on by the front panel switch, it can be released by the remote control engine kill key.

4a.  Switch on the front panel activates (optional) diesel testing.

Front Panel Scope Adjustments

The following controls on the tester front panel are used to adjust scope patterns:

5.  BRIGHTNESS - adjust the intensity of the pattern shown on the scope.

6.  HORIZONTAL POSITION - adjusts the position of the pattern on the scope, left to right.

7.  VERTICAL POSITION - adjusts the position of the pattern on the scope, up or down.

8.  SWEEP LENGTH - adjusts the horizontal length of the pattern.

9.  RASTER SPACING - adjusts the spacing of the individual cylinder patterns, when the RASTER display is selected.

Basic Scope Scales

The basic scope displays ignition and charging system waveforms on all test pages and utilizes two vertical scales to measure voltage, and two horizontal scales to measure dwell and milliseconds. The scales are:

10. VERTICAL (0 to 25) scale, divided in increments of 1V/1kV (25kV = 25,000V).
    0 - 25 V range is used when testing the primary circuit.
    0 - 25 kV range is used for secondary circuit testing.

    This 0 - 25 scale is to be used if "25 V" or "25 kV" is displayed in reverse video on the VDU after making a V selection on the remote control.

11. VERTICAL (0 to 50) scale, divided in increments of 20V/2kV (50kV = 50,000V).
    0 - 500 V range is used when testing the primary circuit.
    0 - 50 kV range is used for secondary circuit testing.

    This 0 - 50 scale is to be used if "500 V" or "50 kV" is displayed in reverse video on the VDU after making a V selection on the remote control.

12. HORIZONTAL PERCENT OF DWELL (100-0%) scale, divided in increments of 2%.

13 HORIZONTAL MSEC scale, divided into 5 major increments of 1 millisecond, each major increment further divided into 5 smaller increments each representing 0.2 of a millisecond.

    The MSEC scale is selected by pressing the mS key on the remote control.

Enhanced Scope ("Lab Scope") Scales

The enhanced analog scope adds a pinpoint test mode to the MEA-1500 SL.
The pinpoint test mode is entered by twice depressing the mm key on the remote control.

Three VERTICAL VOLTAGE scales (50V, 25V, 5V) can be selected sequentially by pressing the V key on the remote control.

Three HORIZONTAL MSEC scales (5 mSec, 25 mSec, 100 mSec and 100 % duty cycle scale) can be selected by pressing the mS key successively.

Select the TRIGGER POLARITY by pressing the 12 +/- key.

TEST PREPARATION.

Self-test/Warm-up

1. Plug the tester power cord into the proper power outlet. See the nameplate on the tester for power requirements.

2. Push the two-position AC power switch (tester ON, tester OFF) to the tester ON position (Figure 27). A title page (Figure 28), with a copyright notice and software version number, will be displayed upon power-up.

3. If the printer option is installed, align the paper perforation with the cutting edge of the printer cover by turning the platen knob.

4. Press ⊞ to display the Self-Test/Warm-up page (figure 29). The analyzer will then perform an automatic self-test. If a system fault is detected, a message describing the fault appears.

5. If the 4-gas emissions option is installed, a 15-minute warm-up timer will be displayed. If the ⊞ key is pressed before the warm-up is complete, the tester will calibrate all items except HC, CO, and CO_2.
Testing of the vehicle may begin, but readings of these gases will not appear. Repeating the calibration process fifteen minutes later will allow gases to calibrate.

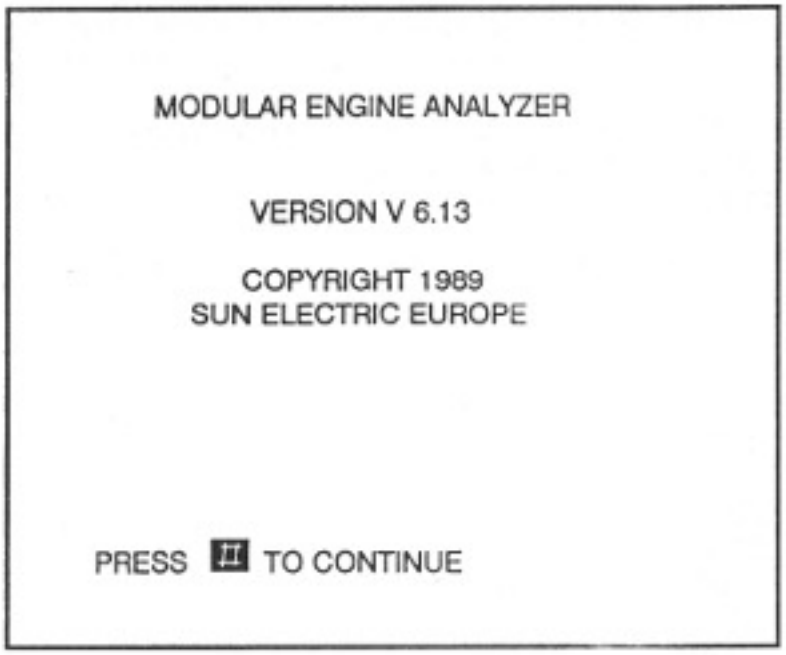


FIGURE 28. This is the first page the operator will see after the MEA-1500 SL is turned on.

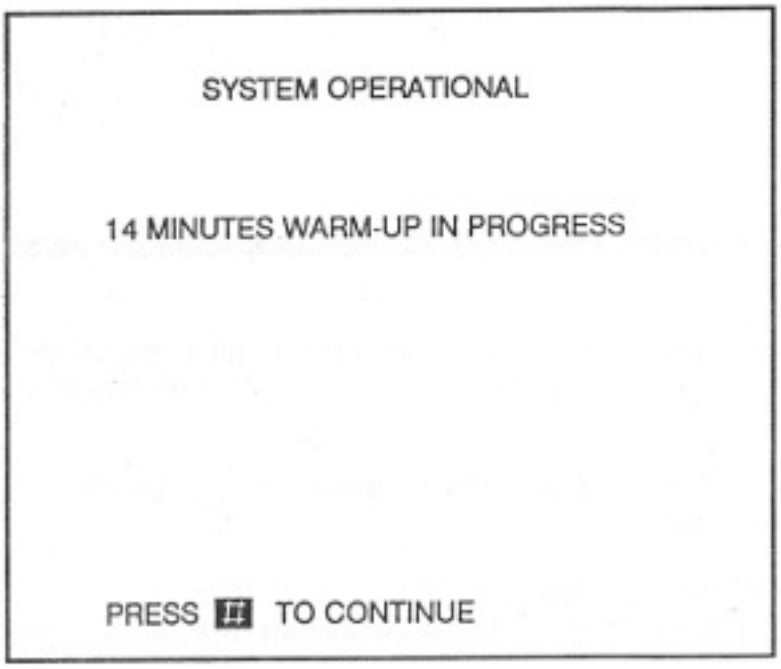


FIGURE 29. "SYSTEM OPERATIONAL" means the analyzer has passed its self-test and everything is in working order. The warm-up timer only appears if the emissions module is installed.

Calibration

6. Press the key. The CALIBRATION page (Figure 30) will be displayed. Short the volt-ohm leads together (reference Figure 32)
The message SHORT VOLT/OHM leads will flash on and off on the VDU until this is done. Do not attempt tester calibration while the test leads are attached to a vehicle. Incorrect calibration will result.(Optional items not installed will not be displayed on this page.)

7. The tester will automatically self-calibrate all items displayed in Figure 30, displaying GOOD, NOT CALIBRATEDor SERVICE REQUIRED next to each parameter.
The calibration may be restarted at any time by pressing the CE key.

8. When calibration is complete, the message PRESS P or will appear at the bottom of the VDU.

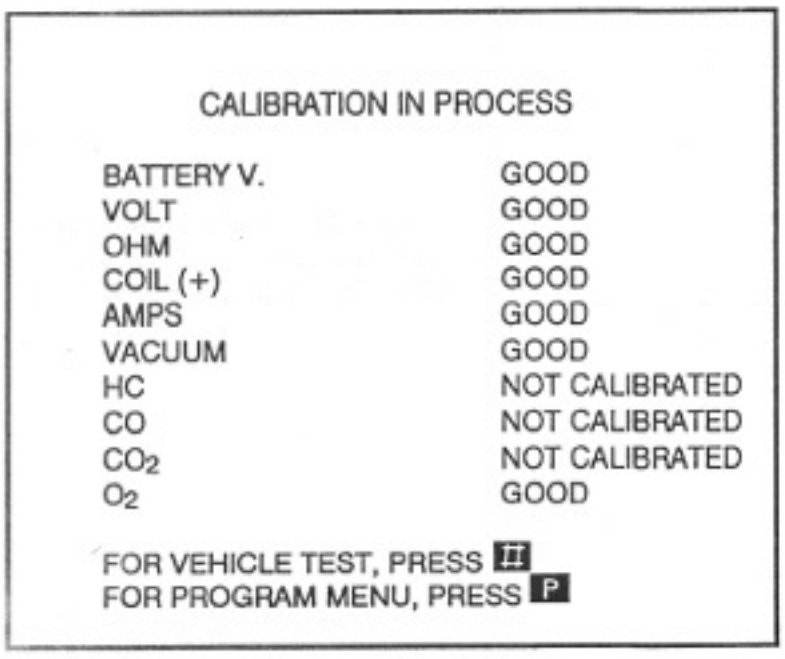


FIGURE 30. "Good" or "Service Required" or "Not Calibrated" will appear next to each item as the MEA electronically calibrates itself. The HC, CO, and CO_2 readings will not calibrate until the 15 minute warm-up is complete.

NOTE: If the emissions module is installed an automatic calibration message ***(AUTOCAL)*** *will appear on the VDU, every 15 minutes when an EMISSION TEST page is in use. The* ***AUTOCAL*** *message will stay on the VDU for 20 seconds, within this time the tester checks and adjusts the emissions module. After the automatic zero calibration the tester returns to the test page. When there is a measurement of 8 % CO_2 or more the autocal will not be executed.*
When the ***AUTOCAL*** *message appears on the VDU the keys on the remote control will not respond until the message disappears.*

Vehicle Set-up

9. The tester is automatically set-up for 4-cylinder, 4-cycle engines, -20.0 degrees magnetic offset angle, mBar, Lambda and Super. If these set-up specifications do not need to be altered, the operator may proceed directly to the VEHICLE TEST page by pressing the ↵ key. If the vehicle set-up does need to be changed, the operator may select the VEHICLE SET-UP page (Figure 31) by pressing the ⇦ key in the VEHICLE TEST pages.(If the P key is pressed the VEHICLE SET-UP page is entered by pressing the number 1 key on the remote control.

   To change the test parameters, press the ▷ key to advance the cursor to the data line which is to be changed, then press the CE key. Enter the new data using the numeric keys on the remote control. If the entry flashes on the screen, it is out of limit. Check the number and re-enter.

```
            VEHICLE SET-UP

ENTER NO. OF CYLINDERS              4
ENTER NO. OF CYCLES                 4
ENTER MAGNETIC OFFSET             - 20.0
1 - "HG  / 2 - MBAR                 2
1 - AFR  / 2 - LAMBDA               2
FUEL TYPE                           1
1 = SUPER
2 = REGULAR
3 = LPG


ENTER VEHICLE DATA, PRESS ▷
TO RETURN TO PROGRAM, PRESS ↵
```

FIGURE 31. The MEA-1500 SL is automatically preset for these vehicle specifications

Lead Connections

10. Connect the test leads always with the **engine off** (Figure 32) as follows:

    a. If the vehicle being tested is equipped with a magnetic timing probe receptacle, install the magnetic probe in the receptacle, with adapter if required.

    b. If the vehicle does not have a magnetic probe or the magnetic timing option is not installed, check timing with the timing light. Clean the crankshaft pulley and the timing pointer while the engine is still off. Use a piece of chalk or white touch-up paint to paint the Zero Degree Line on the pulley and the pointer for visibility.

c. Turn the timing advance knob on the timing light fully counter clockwise (off) until it clicks. Then place the on/off button in the "off" position (white dot out).

d. Clamp the GREEN-booted primary connector to the Tach or (-) coil terminal.

e. Clamp the YELLOW-booted connector (black lead) to the positive terminal of the coil. Both the coil(-) and coil(+) connectors will be part of a single BLACK twinflex lead.

f. Clamp the CHROME pattern pick-up (BLUE lead) around the coil high-tension cable.

NOTE: If system does not have a coil high-tension cable, SUN options are needed, for example, the HEI adapter for GM engines or WSA-150.

g. Clamp the RED-booted connector (black twinflex lead) to the positive battery terminal.

h. Clamp the BLACK-booted connector (Black twinflex lead) to the negative battery terminal.

i. If the vacuum/amps option is installed, clamp the GREEN ammeter pick-up around the negative battery cable(around all cables if there is more than one) with the arrow on the pick-up pointing away from the battery.

j. Clamp the RED trigger pick-up (RED lead) around the number one spark plug cable as close to the distributor cap as possible.

k. If the vacuum/amps option is installed, connect the vacuum hose to a direct source of engine vacuum. Be careful with any other source connections, such as ported vacuum or vacuum reservoir.

l. If an emissions module is installed, disable the air pump to prevent sample gas dilution by clamping or pinching off the hoses or tubes at the air pump or engine. Some manufacturers recommend disconnecting and plugging the tubes leading from the air pump.
Consult each manufacturer's specific recommendations.

1. Disable Pulse-Air systems to prevent sample gas dilution by plugging tubes at the air cleaner.

   NOTE: To prevent damage to the air pump, close off hose after diverter valve.

2. Insert the sampling probe into the tailpipe, at least 12 inches.(30 cm)

3. Connect exhaust ventilation to the tailpipe.

4. Turn the two-position pump switch on the back of the tester to the OPERATE position.(program versions V 6.00 or lower)

m. Turn all vehicle accessories off.

n. Place the vehicle's shift lever in PARK if it has an automatic transmission and set the parking brake; on vehicles with manual transmissions, place the shift lever in the NEUTRAL position and set the parking brake.

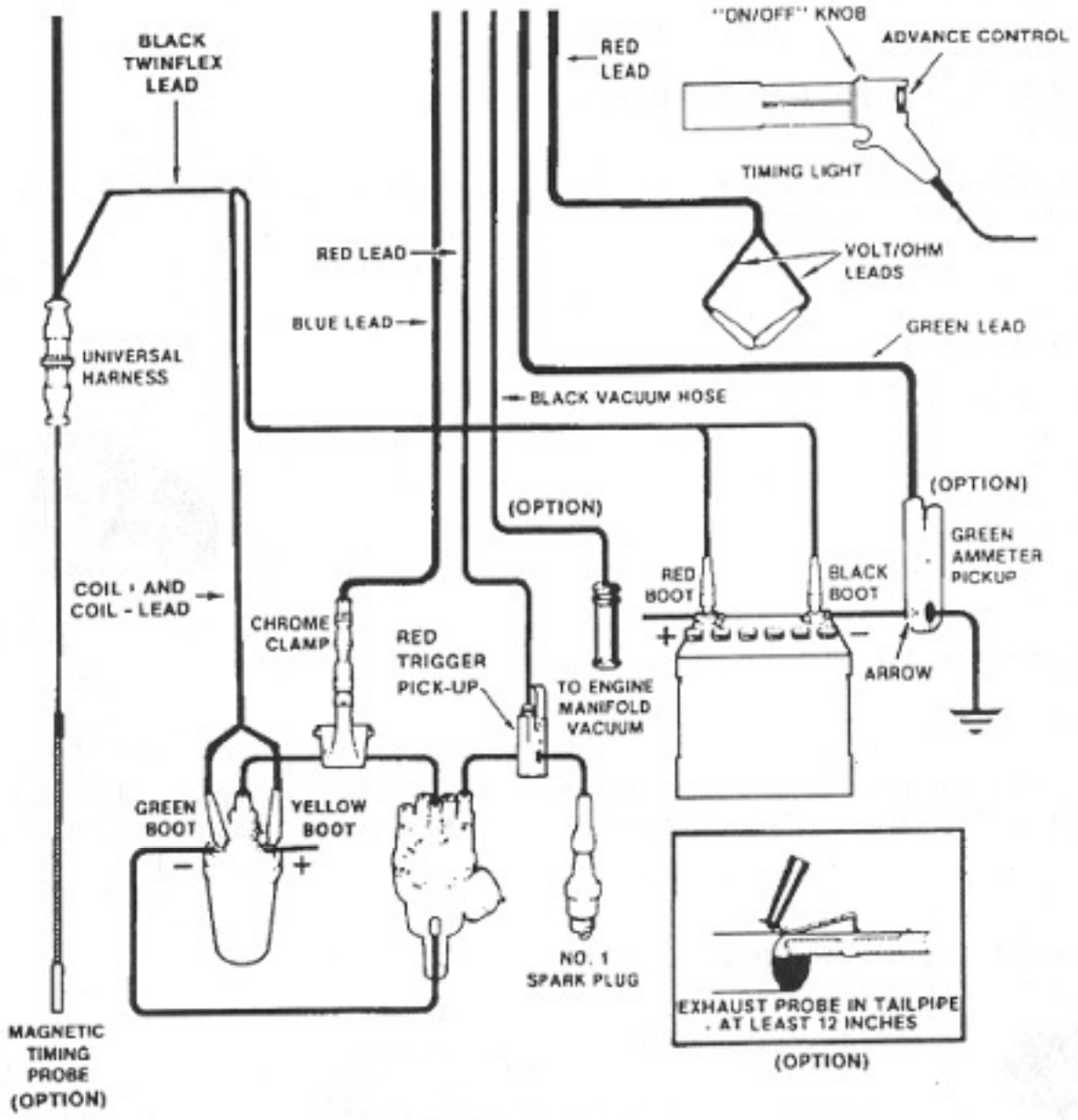


FIGURE 32. Tester Hook-up to Vehicle.

TEST PROCEDURES

The following section details a variety of tests which can be performed using the ENGINE ELECTRICAL, ADJUSTMENTS/EMISSIONS, and POWER BALANCE test pages, and the ignition oscilloscope. The tests may be used selectively to check for suspected problems or in the entirety to check overall engine performance.

STANDARD TEST PROCEDURE

The standard test procedure is a suggested sequence of engine tests performed under various operating conditions, including:

1) Key-off, engine-off

2) Key-on, engine-off

3) Cranking

4) High cruise

5) Low cruise

6) Idle

7) Snap acceleration

8) Power balance

The tests above are described on the following pages for both standard and optional MEA-1500 SL test capabilities. Be sure to note the capabilities of your MEA-1500 SL before proceeding with the tests.

1. Key-Off, Engine-Off Tests

CHECK BATTERY VOLTAGE AND CURRENT DRAW AS FOLLOWS:

a. Turn the engine off, close all the doors and turn off all the accessories.

b. Note the readings for Battery and Current.. The bold areas on Figure 33 indicate which lines should be read.

c. If desired, press the [F] key to record the results.

Test Mode	Test	Read	Test Indications - Good
Engine off	Battery	VDU	12.4V or higher for 12V systems
Key Off	Current	VDU	Near 0

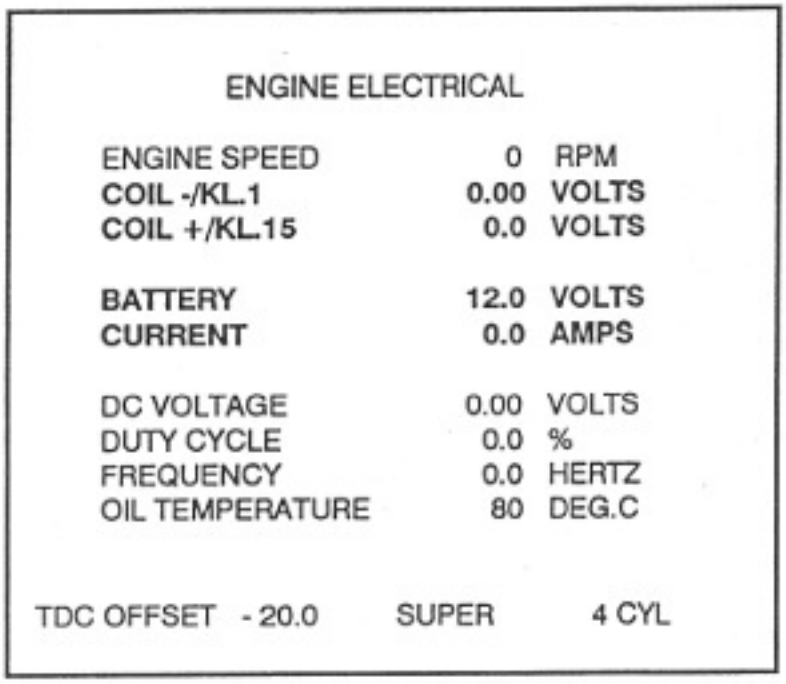


FIGURE 33.

2. Key-On, Engine-Off Tests

CHECK BATTERY VOLTAGE, CURRENT DRAW, COIL (+) AND COIL (-) AS FOLLOWS:

a. Turn the ignition key to on, but do not start the engine.

b. Note the readings. The bold areas on Figure 34 indicate which lines should be read.

c. If desired, press the  key to record the results.

Test Mode	TestRead	Test	Indications - Good
Engine off	Coil (-)	VDU	Depends on vehicle type
Key On	Coil (+)	VDU	Close to battery voltage
	Battery	VDU	12 Volts or higher
	Current	VDU	Depends on vehicle type

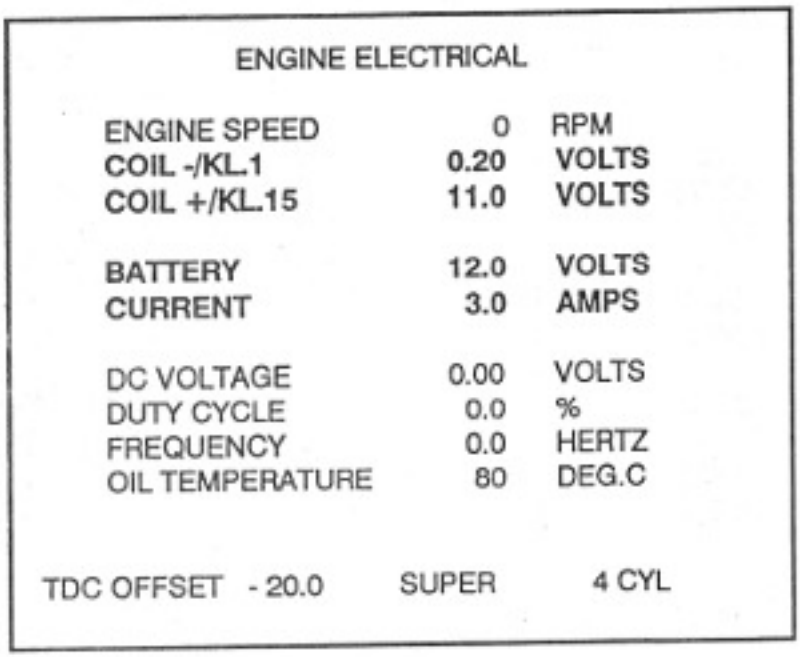


FIGURE 34.

3. Cranking Tests

NOTE: Perform cranking tests under no-start and hard-start conditions. Where possible, the  *button should be used to prevent the engine from starting.*

PERFORM CRANKING TESTS AS FOLLOWS:

a. If the engine is carbureted and the emissions module is installed, pump the accelerator once to insure that some fuel enters the engine to be sensed at the tailpipe. If the engine diesels, let the engine cool or pump the accelerator pedal several times before repeating the test. If the vehicle has a catalytic convertor disconnect the fuel supply when the test has to be repeated, it is not necessary to pump the accelerator pedal.

b. Crank the engine until test data stabilizes, but no longer than 15 seconds at a time.

c. If desired, press the  key to hold the cranking readings for analysis, or press  to record them while the engine is cranking.

d. The bold areas on Figures 35 and 36 indicate which lines should be read.

NOTE: If the four-gas option is installed, the appearance of LOW FLOW or PUMP OFF messages indicate that certain conditions should be corrected before proceeding. Turn the gas pump switch to the OPERATE position, or refer to "Maintenance and Service" to correct low flow.

Test Mode	Test	Read	Test Indications - Good
Cranking	Engine Speed	VDU	Min 140-300(4 cyl)130-230(6 cyl) 120-200 (8 cyl)
	Coil (+)	VDU	Close to battery voltage
(Fig.35)	Battery	VDU	9.6 Volts or higher
	Current	VDU	Max 90-220(4 cyl)130-250(6 cyl) 210- 280 (8 cyl)
	Dwell	VDU	Refer to manufacturer's spec.
(Fig.36)	Vacuum	VDU	Depends on connection
	HC	VDU	Carb over 1000 PPM. Fuel injection as low as 0

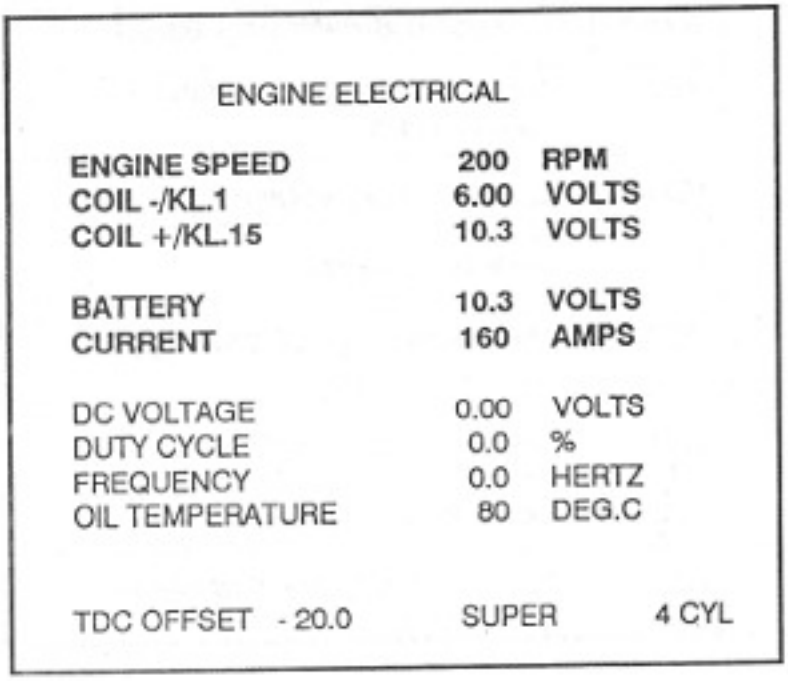


FIGURE 35.

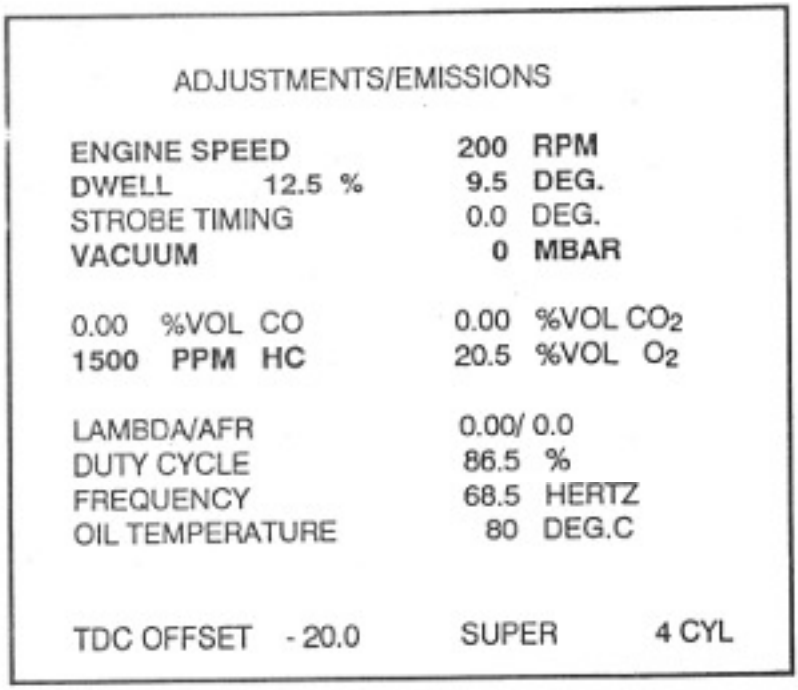


FIGURE 36.

4. High Cruise Tests

PERFORM THE VDU PORTION OF THE HIGH CRUISE TESTS AS FOLLOWS:

a. Accelerate the engine to approximately 2500 RPM (plus or minus 100 RPM) and maintain it for 15 to 20 seconds or until data stabilizes.

b. If the magnetic timing option is installed, timing will be automatically displayed. The magnetic timing offset angle selected on the VEHICLE SET-UP page will be shown at the bottom of the VDU. If the set-up is made incorrectly the tester automatically updates this angle for European vehicles only.

c. If the timing light is used, check the timing advance by setting the on/off switch on top of

the timing light in the ON position. Then turn the timing advance control on the timing light clockwise until it clicks on. Point the timing light at the timing pointer, then turn the advance control until the mark on the crankshaft pulley lines up with the ZERO degree mark on the cover.
NOTE: On engines that have timing degree marks stamped in the timing chain cover, line up the mark on the crankshaft pulley with the ZERO degree mark on the cover.

d. After the above procedure, strobe timing in degrees will appear on the VDU.

e. When test data stabilizes, press the ✱ key to hold the high cruise readings for analysis, or press F7 to record them. The bold lines in Figures 37 and 38 indicate which lines should be read.

PERFORM THE SCOPE PORTION OF THE HIGH CRUISE TESTS AS FOLLOWS:

a. Maintain the 2500 RPM test speed while performing the scope tests:

1. **Alternator Condition.** Set the scope to ⎍ mode and ∿ waveforms. Note the uniformity of the ripple waveform.

2. **Firing Voltage.** Set the scope to hh mode, 25 KV scale, and kV waveform. Observe the voltage levels of the firing lines.

3. **Coil Oscillations.** Set the scope to ⎍ mode and either V or kV scope scale. Look for 4 or more gradually diminishing oscillations in the intermediate section of the waveform.

4. **Spark Duration.** Set the scope to V mode and ms waveform. Note the spark lines.

5. **Cylinder Timing.** Set the scope to hh mode and either V or kV waveform, on the low scale ▭ . Observe the point open or close signal for variation. On electronic ignition systems, the transistor off signals are to be observed for variation.

Test Mode	Test	Read	Test Indications - Good
High Cruise	Engine Speed	VDU	2400 to 2600 RPM
(Fig.37)	Battery	VDU	13.2 to 14.5 Volts
	Current	VDU	5 Amps or greater
(Fig.38)	Dwell	VDU	Refer to manufacturer's spec's
	Timing	VDU	Refer to manufacturer's spec's
	Vacuum	VDU	600 mBar or higher
	CO	VDU	Lower than low cruise CO
	CO_2	VDU	Same as low cruise CO_2
	HC	VDU	Lower than low cruise HC
	O_2	VDU	Higher than low cruise O_2

Test Mode	Test	Read	Test Indications - Good
	Lambda	VDU	Between 0.95 and 1.05
	AFR	VDU	Between 14.7 and 15.3
	Alternator	Scope	See "Oscilloscope Testing"
	Firing Voltage	Scope	See "Oscilloscope Testing"
	Coil oscillations	Scope	See "Oscilloscope Testing"
	Spark duration	Scope	See "Oscilloscope Testing"
	Cylinder timing	Scope	See "Oscilloscope Testing"

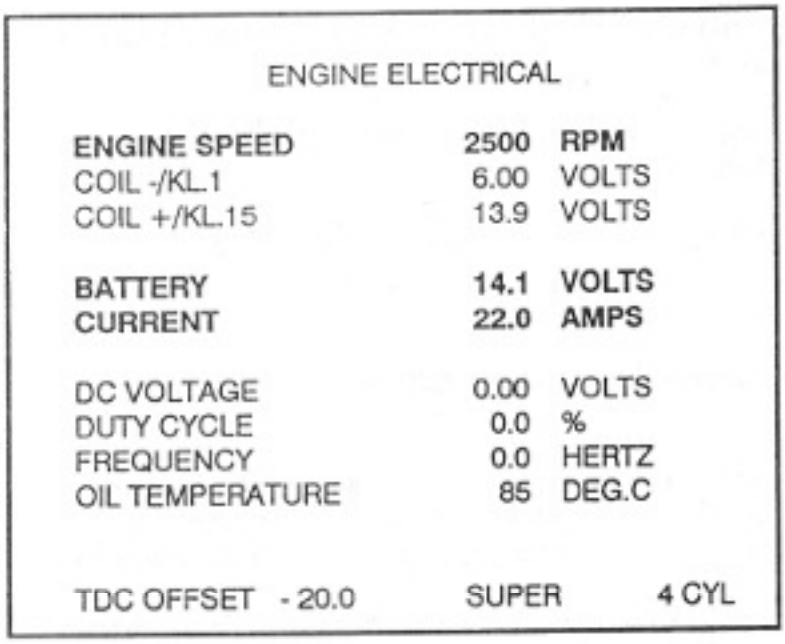


FIGURE 37.

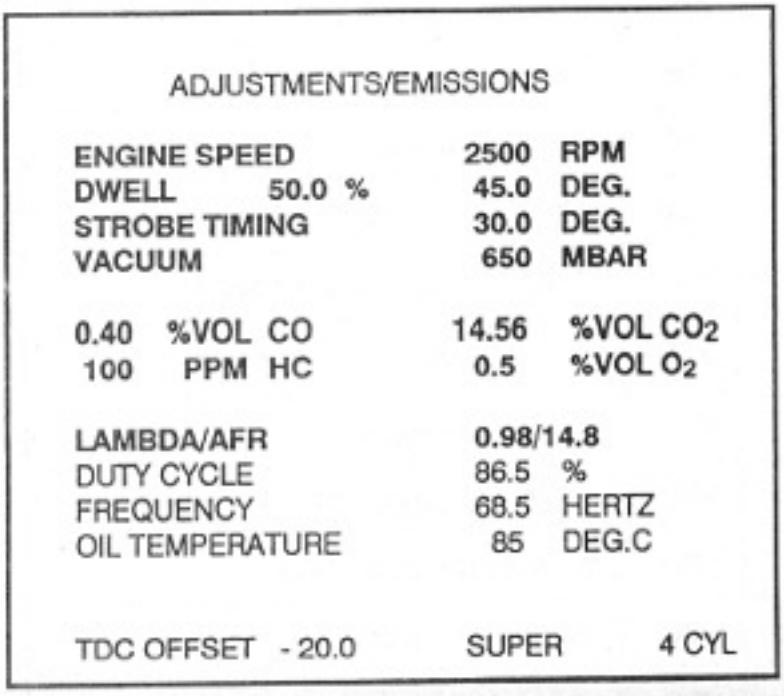


FIGURE 38.

5. Low Cruise Tests.

PERFORM THE LOW CRUISE TESTS AS FOLLOWS:

a. Accelerate the engine to approximately 1500 RPM (plus or minus 100 RPM) and maintain until HC and CO stabilize.

b. If the magnetic timing option is installed, timing will be automatically displayed. The magnetic timing offset angle selected on the VEHICLE SET-UP page will be shown at the bottom of the VDU. If the set-up is made incorrectly the tester automatically updates this angle for European vehicles only.

c. If the timing light is used, check the timing advance by setting the on/off switch on top of the timing light in the ON position. Then turn the timing advance control on the timing light clockwise until it clicks on. Point the timing light at the timing pointer, then turn the advance control until the mark on the crankshaft pulley lines up with the ZERO degree mark on the cover.

NOTE: On engines that have timing degree marks stamped in the timing chain cover, line up the mark on the crankshaft pulley with the ZERO degree mark on the cover.

d. After the above procedure, strobe timing in degrees will appear on the VDU.

e. When test data has stabilized, press the key to hold the high cruise readings for analysis, or press to record them. The bold lines in Figures 39 and 40 indicate which lines should be read.

PERFORM THE SCOPE PORTION OF THE HIGH CRUISE TESTS AS FOLLOWS:

a. Maintain the 1500 RPM test speed while performing the scope tests:

1. **Alternator Condition.** Set the scope to mode and waveforms. Note the uniformity of the ripple waveform.

2. **Firing Voltage.** Set the scope to mode, 25 KV scale, and waveform. Observe the voltage levels of the firing lines.

3. **Coil Oscillations.** Set the scope to mode and either or scope scale. Look for 4 or more gradually diminishing oscillations in the intermediate section of the waveform.

4. **Spark Duration.** Set the scope to mode and waveform. Note the spark lines.

5. **Cylinder Timing.** Set the scope to mode and either or waveform, on the low scale . Observe the point open or close signal for variation. On electronic ignition systems, the transistor off signals are to be observed for variation.

ENGINE ELECTRICAL

ENGINE SPEED	**1500**	**RPM**
COIL -/KL.1	6.00	VOLTS
COIL +/KL.15	13.9	VOLTS
BATTERY	**14.1**	**VOLTS**
CURRENT	**10.0**	**AMPS**
DC VOLTAGE	0.00	VOLTS
DUTY CYCLE	0.0	%
FREQUENCY	0.0	HERTZ
OIL TEMPERATURE	85	DEG.C

TDC OFFSET - 20.0 SUPER 4 CYL

FIGURE 39.

Test Mode	Test	Read	Test Indications - Good
Low Cruise	Engine Speed	VDU	1400 to 1600 RPM
(Fig.39)	Battery	VDU	13.2 to 14.5 Volts
	Current	VDU	2.5 Amps or greater
(Fig.40)	Dwell	VDU	Refer to manufacturer's spec's
	Timing	VDU	Refer to manufacturer's spec's
	Vacuum	VDU	Higher than idle
	CO	VDU	Lower than idle CO
	CO_2	VDU	Same as idle CO_2
	HC	VDU	Lower than idle HC
	O_2	VDU	Higher than idle
	Lambda	VDU	Between 0.95 and 1.05
	AFR	VDU	Between 14.7 and 15.3

ADJUSTMENTS/EMISSIONS

ENGINE SPEED		**1500**	**RPM**
DWELL	**30.0 %**	**27.0**	**DEG .**
STROBE TIMING		**30.0**	**DEG.**
VACUUM		**650**	**MBAR**
0.50	**%VOL CO**	**13.56**	**%VOL CO_2**
100	**PPM HC**	**0.8**	**%VOL O_2**
LAMBDA/AFR		**0.95/14.5**	
DUTY CYCLE		86.5	%
FREQUENCY		68.5	HERTZ
OIL TEMPERATURE		85	DEG.C

TDC OFFSET - 20.0 SUPER 4 CYL

FIGURE 40.

6. Idle Tests.

PERFORM THE VDU PORTION OF THE IDLE TESTS AS FOLLOWS :

a. Check the vehicle manufacturer's recommended curb idle speed and set-up conditions and follow the recommended procedure.

b. Check the vehicle manufacturer's initial timing, speed and set-up conditions and follow the recommended procedure.

c. Bring the engine to the vehicle manufacturer's recommended initial timing speed (plus or minus 50 RPM), and repeat timing procedures.

d. When test data has stabilized, press the ✱ key to hold the high cruise readings for analysis, or press F7 to record them. The bold lines in Figures 41 and 42 indicate which lines should be read.

PERFORM THE SCOPE PORTION OF THE IDLE TESTS AS FOLLOWS:

a. Maintain the idle test speed while performing the scope tests:

1. **Firing Voltage.** Set the scope to ms mode, 25 KV scale, and kV waveform. Observe the voltage levels of the firing lines.

2. **Coil Oscillations.** Set the scope to ms mode and either V or kV scope scale. Look for 4 or more gradually diminishing oscillations in the intermediate section of the waveform.

3. **Spark Duration.** Set the scope to ms mode and ms waveform. Note the spark lines.

4. **Cylinder Timing.** Set the scope to ms mode and either V or kV waveform,

on the low scale . Observe the point open or close signal for variation. On electronic ignition systems, the transistor off signals are to be observed for variation.

Test Mode	Test	Read	Test Indications - Good
Idle Engine	Speed	VDU	Curb idle see manufact. spec.
(Fig.41)	Battery	VDU	13.2 to 14.5 Volts
	Current	VDU	Minimum of 2 Amps
(Fig.42)	Dwell	VDU	Refer to manufacturer's spec's
	Timing	VDU	Refer to manufacturer's spec's
	Vacuum	VDU	Varies with model and altitude
	CO	VDU	Refer to manufacturer's spec.
	CO_2	VDU	As high as 14 to 15 percent CO_2
	HC	VDU	200 to 300 ppm HC
	O_2	VDU	Lower than 2 percent
	Lambda	VDU	Between 0.95 and 1.05
	AFR	VDU	Between 14.7 and 15.3
	Firing Voltage	Scope	See "Oscilloscope Testing"
	Coil oscillations	Scope	See "Oscilloscope Testing"
	Spark duration	Scope	See "Oscilloscope Testing"
	Cylinder timing	Scope	See "Oscilloscope Testing"

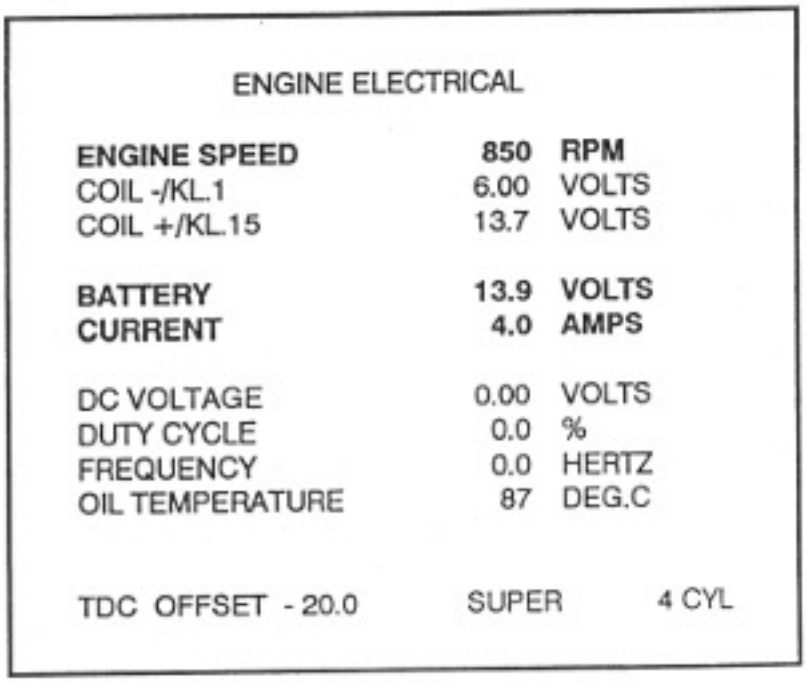


FIGURE 41.

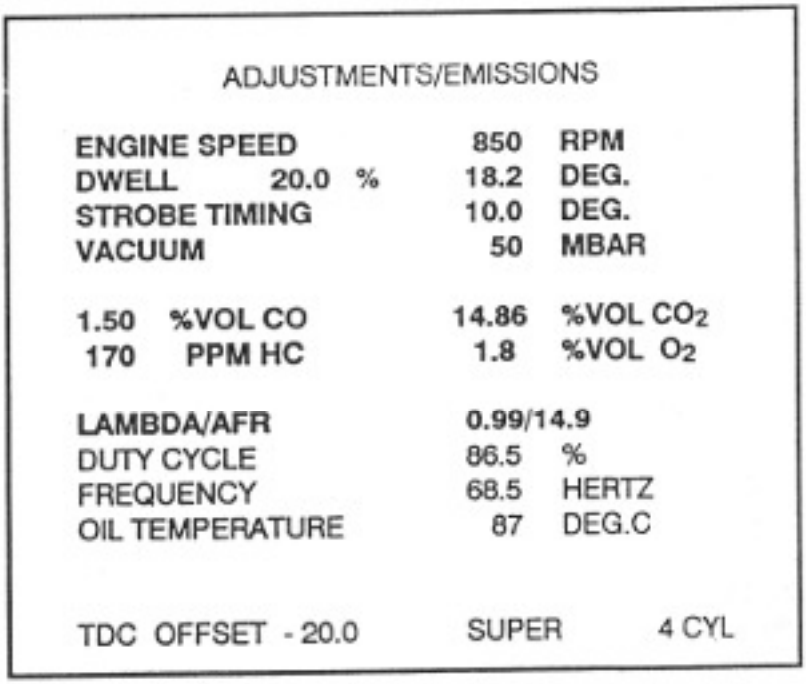


FIGURE 42.

GUIDE TO FOUR - GAS SPECIFICATIONS

7. Snap Acceleration Tests.

PERFORM THE SNAP ACCELERATION TESTS AS FOLLOWS:

a. Set the scope to hh mode, kV waveform and 25 KV scale.

b. Snap accelerate the engine by rapidly pushing the accelerator to the floor and release it at once.

c. Observe the voltage levels of the increase of the firing lines on the scope.

d. Press * to hold the snap acceleration readings for analysis, or press to record them. The bold area in Figure 43 indicates which line should be read.

Test Mode	Test	Read	Test Indications - Good
Snap Acceleration	Firing voltage under load	Scope	See "Oscilloscope Testing"
	CO Change	VDU	Minimum increase of 1 %

ADJUSTMENTS/EMISSIONS

ENGINE SPEED		2650	RPM
DWELL	30.0 %	28.2	DEG.
STROBE TIMING		0.0	DEG.
VACUUM		50	MBAR
2.65	**%VOL CO**	12.86	%VOL CO_2
470	PPM HC	2.8	%VOL O_2
LAMBDA/AFR		0.92/13.5	
DUTY CYCLE		86.5	%
FREQUENCY		68.5	HERTZ
OIL TEMPERATURE		87	DEG.C

TDC OFFSET - 20.0 SUPER 4 CYL

FIGURE 43.

*NOTE: If the automatic calibration message (**AUTOCAL**) appears on the VDU, the tester will not respond to the keys on the remote control. After the automatic zero control the **AUTOCAL** message will disappear and the tester will proceed in the normal test mode.(See test preparation and calibration).*

THE KEY - AIR/FUEL RATIO - LAMBDA

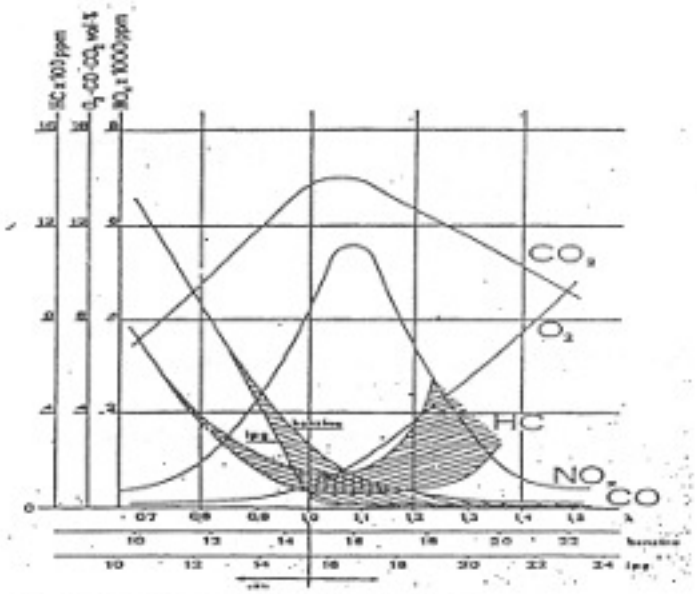


FIGURE 44. Graphic of the gasses

Air-fuel ratio:

This is the relationship between the amount of air and fuel entering an engine when it is running. An adjustment has to be made when the relationship between the air and fuel is incorrect. The combustion is most efficiently when the air-fuel ratio is adjusted to the Stoichiometric point. This point is reached when the ratio of the amount of air to the amount of fuel equals 14.7 : 1, for a vehicle without a catalytic converter.
When the vehicle has a catalytic converter an oxygen sensor monitors the amount of oxygen in the exhaust gas and gives a signal to the fuel supply controlling device to change the amount of fuel entering the engine to achieve the correct fuel to air ratio.

Lambda:

Lambda is a value which is calculated from the composition of the exhaust gas. For an efficiently operating engine, Lambda should have a value close to 1.00.
The calculation of Lambda is only possible when a 4-gas emissions analyzer module is installed and the fuel type has been correctly selected. The tester's computer calculates the Lambda value from the composition of the exhaust gas according to the Spindt method.
When Lambda is over 1.00, the engine runs "lean", if Lambda is under 1.00, the engine runs "rich".

The Lambda/AFR measurement is extremely useful when testing vehicles equipped with a catalytic converter. Because the catalytic convertor changes the exhaust gas composition significantly, it is not possible to diagnose, whether the engine is running rich or lean with a gas analyzer which is not capable of calculating Lambda and/or AFR.
Therefor the operator needs to monitor the Lambda/AFR readings only to obtain conclusive information.

An engine with a catalytic converter should operate with a Lambda value between 0.97 and 1.03. If the Lambda value is not within this range, either the converter is not working, the engine is still

warming up, or the Lambda sensor in the exhaust is out of order. When a carburetor is adjusted so that the Lambda value becomes 1.00, the AFR (Air-Fuel Ratio) has to be 14.7, see graphic Figure 44.

8. Power Balance Tests.

Return to the PROGRAM MENU by pressing the P key, and select POWER BALANCE TEST. The POWER BALANCE TEST page (Figure 45) will be displayed.

a. Prepare for POWER BALANCE TESTS.

1. Use a jumper wire to keep the electric cooling fan ON during the test.

2. Disable RPM and carburetor mixture feedback controls per manufacturer's recommendation.

3. Disconnect and plug the EGR vacuum hose.

4. Stabilize the engine at the desired test speed, not less than 1000 RPM.

NOTE: If the TRIGGER PICK-UP NOT SENSED or COIL CONNECTION NOT PRESENT messages appear and "flash"(when engine is running), check the GREEN primary lead or the RED trigger pick-up for proper connections.

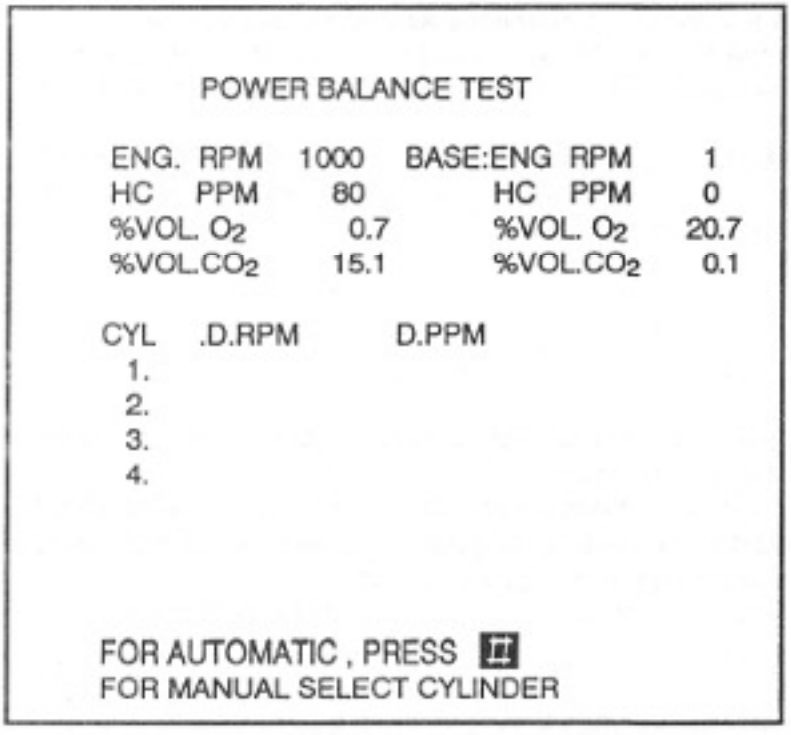


FIGURE 45. Help messages that detail how to prepare the vehicle for power balance tests are available for this test page.

b. Either an automatic or a manual power balance test can be performed from the POWER BALANCE TEST page.

1. To perform an automatic power balance test, press key. The analyzer will automatically short out one cylinder at a time. The difference between RPM before shorting (BASE RPM) and RPM when shorted, is displayed as RPM CHANGE.

A new BASE RPM is computed for each cylinder as it is shorted. The test is complete when data for all cylinders is displayed (Figure 46).

Power balance test results will remain displayed until they are cleared. It is not necessary to freeze results. If desired, test results may be printed out at any time during manual or automatic power balance tests.

If an emissions module is installed, the automatic power balance test also displays the HC change. The difference between HC readings before cylinder shorting and the highest HC reading during and after cylinder shorting will be captured and the HC change is displayed on the test page. (This capability is only available with program version 6.10 or higher)

When a cylinder is shorted the fuel in that cylinder will not combust. When the exhaust gas analyzer is used during the cylinder balance test it will show an increase of unburned fuel in the exhaust gases.

Unburned gases cause the exhaust gas analyzer to register approximately 1700 ppm HC (hydrocarbons). By observing the HC output change, a diagnosis of the engine is possible, e.g. adjustment of valve clearances, injector function, condition of the manifold gasket or the carburetor.

In the case of fuel injection engines the difference between the HC output change per cylinder is approximately 150 ppm HC. Carburetor engines may have a higher HC difference of approximately 300 ppm HC. The MEA 1500 SL measures the HC change automatically in the cylinder balance test. (This capability is only available with program version 6.10 or higher)

POWER BALANCE TEST

ENG. RPM	1000	BASE:ENG RPM	1
HC PPM	80	HC PPM	0
%VOL. O_2	0.7	%VOL. O_2	20.7
%VOL. CO_2	15.1	%VOL.CO_2	0.1

CYL.	D .RPM	D. PPM
1	165	1650
2	145	1550
3		
4		

FIGURE 46 .Power Balance Test page.

2. To perform manual power balance tests, select the cylinder or cylinders to be shorted by pressing the remote control numeric keys corresponding to the cylinder number(s).

NOTE: If the automatic power balance tests preceded the manual power balance tests, and the previous data was not cleared, the RPM CHANGE reading from the previous test will be retained until cylinders are shorted manually and new readings are displayed.

3. If a new cylinder is shorted within two seconds the last cylinder being unshorted, the same BASE RPM will be used to calculate the new RPM CHANGE. If more than two seconds elapse after the last cylinder was unshorted, a new BASE RPM will be used to calculate RPM CHANGE.

NOTE: When using the second method described above, allow the engine speed to stabilize after the cylinder is shorted out. Do not allow any cylinder to be shorted out for more than 10 seconds, or damage to the catalytic converter may result. To unshort a cylinder press the **CE** *key.*

4. If the engine being tested is a carbureted V-6, V-8 or horizontally-opposed engine with a multi plane intake manifold, perform a fuel balance test.

   a. Press the key numbers corresponding to the ODD-numbered cylinders. This will short out the cylinders fed by one carburetor barrel.

NOTE: The cylinder numbers have to be entered quickly one after another. When there is much delay between entering the numbers of the cylinders to be shorted the computer will only short out the cylinder corresponding to the first number depressed. When the first cylinder is shorted by the computer it will no longer accept input of more cylinder numbers for shorting.

The shorted cylinder is cancelled by pressing **CE** key. The computer stops shorting the cylinder automatically after approximately 10 seconds.

   b. Allow the engine speed to decrease and stabilize and then press the **CE** key to unshort all cylinders. Operate the engine for a few minutes to allow it to return to normal operation. The total engine speed change will be displayed next to each cylinder which was shorted.

NOTE: Do not operate the engine for more than 10 seconds with cylinders shorted.

   c. Press the key numbers corresponding to the EVEN-numbered cylinders. This will short out the cylinders fed by the other carburetor barrel. Allow the engine speed to decrease and stabilize then press **CE**

   d. Compare the RPM lost when all ODD cylinders were shorted to that lost when all EVEN cylinders were shorted. The difference should not exceed 30 RPM.

Test Mode	Test	Read	Test Indications - Good
Power Balance	RPM Change	VDU	Even and within 50RPM cyl to cyl
	HC Change	VDU	Even from cylinder to cylinder

POWER BALANCE TEST

ENG. RPM	1000	BASE: ENG RPM		986
HC PPM	380	HC PPM		85
%VOL. O_2	0.7	%VOL. O_2		1.7
%VOL. CO_2	12.1	%VOL.CO_2		15.1

CYL.	D .RPM	D. PPM
1	165	1650
2	145	1550
3	90	1000
4	150	1650

FIGURE 47. Power balance test complete.

PINPOINT TESTS AND VEHICLE ADJUSTMENTS

When the ENGINE ELECTRICAL page is selected, the analyzer may be used to perform pinpoint tests using its electrical and emission testing capabilities. Measurements on the sixth data line of the test pages are used exclusively for this purpose. The DC VOLTS measurement may be changed to RESISTANCE and back again by pressing the ■ key successively.
Volts or ohms may be measured at any point in a vehicle circuit or component with the volt/ohm leads connected.

NOTE: Do not connect the volt/ohm leads to a "live" source when Ohms is selected. If the enhanced scope is selected it is not possible to change VOLTS into OHMS.

When measurements are made with the VOLT/OHM leads be sure that other test leads are disconnected

The VEHICLE TEST pages may also be used as a guide to perform various vehicle adjustments, such as dwell, timing, curb idle, duty cycle, frequency and fuel mixture.
The continuously updated digital readings on the page will indicate when an adjustment is within specification.

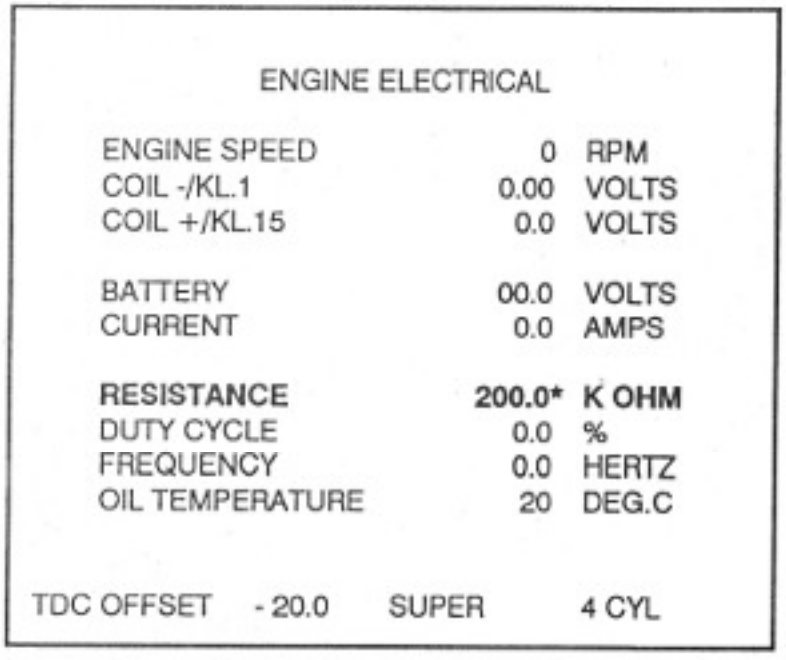


FIGURE 48. The sixth line of the vehicle test pages are used exclusively for pinpoint tests. Over range resistance readings are marked with (*).

ENHANCED SCOPE (Lab Scope).

The Lab scope option has been installed in the MEA 1500 SL to increase the capability of measuring the electronic components of modern vehicles. Signals from components such as fuel injectors, O_2 sensors, air flow sensors, idle rpm control and some solenoids can be displayed using the Lab scope. Measurements are made on the VEHICLE TEST page.

The VOLT/OHM leads must be connected to the desired component to receive a signal and display its waveform on the Lab scope.

The Lab scope mode is entered by depressing the key twice. The scope will automatically display the waveform pattern received from the VOLT-OHM leads.

The first time the Lab scope is used, utilize a familiar signal; an injector signal is a good example.

Clip the black booted connector of the VOLT-OHM leads to vehicle earth and connect the red booted connector to one of the 2 injector wires. *(Note: If connected to the wrong wire , the scope will display a straight line at approximately 14 Volts).*

If connected to the correct wire it gives a signal which starts at approximately 14 Volts, then drops several volts, stays at this level for approximately 2 mSec, goes up to 40 Volts and drop again to remain at approximately 14 Volts. This can only be seen when the scope scales and trigger are correctly set; that is why the Lab scope has three voltage scales each with its own trigger level.

A trigger level means that the tester looks for a voltage which is higher than the trigger level before it begins to display a signal.The trigger level is 20% of the voltage scale.
If the 50 Volt scale is selected, the trigger level of 20% will be at approximately 10 Volts. The injector signal of approximately 14 Volts is above the trigger level of 10 Volts, so the injector signal will be displayed. (A signal of less than 10 Volts would not be triggered on the 50 Volt scale. The 25 Volt or the 5 Volt scale would be needed to trigger a signal of less than 10 Volts).

Always try to get a steady signal on the Lab scope. If the pattern runs across the screen the trigger level is not set correctly. Select Vertical Scales by pressing the button successively until the pattern on the scope is reasonably stationary.

To select the correct trigger polarity press the key on the remote control. If the incorrect polarity is selected the signal on the scope will move up when it should go down. By pressing the key the signal can be displayed correctly.

For a closer examination of the signal it is possible to expand the pattern horizontally by selecting a different time scale. There are four scales to select from. When the 5 mSec scale is selected the pattern is at largest.
If the pattern is out of scale on the scope screen it indicates that the selected time scale is too short. Select a longer scale range(25 mSec, 100 mSec or 100%) by pressing the button on the remote control until a complete pattern is shown on the scope. *(Note: The 100% scale will always show one, complete signal pattern).*

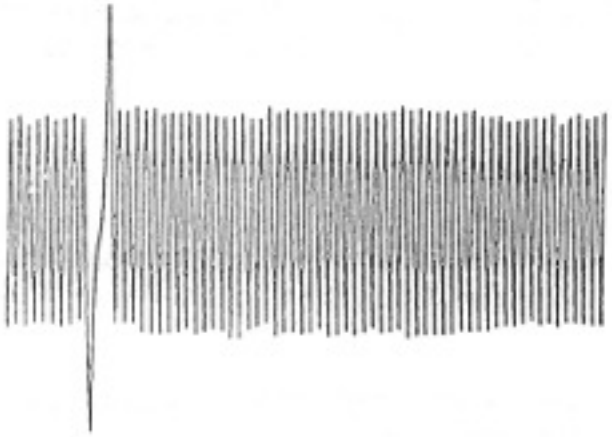
In this way you can display any electronic signal you want to observe, or measure, on the Lab scope.

The last part of the vehicle test page will display the signal's duty cycle and frequency in percent and Hertz (Hz).

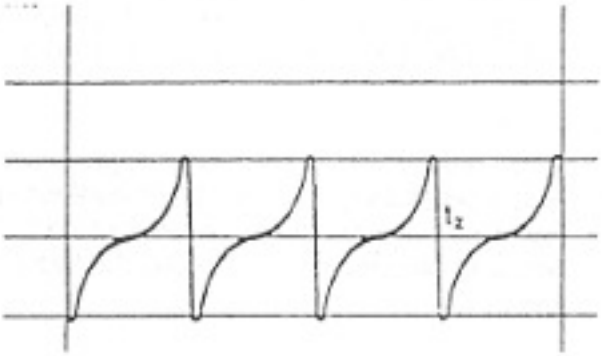
Duty cycle is the ratio of the period of time the signal is turned on relative to the period the signal is turned off. Duty cycle is always expressed as a percentage. For example, if the signal is switched on for 3/4 of the time and off for 1/4 of the time the duty cycle will be 75%.

Frequency means the number of times a signal is switched on and off (or the number of oscillations) per second.
The vehicle manufacturer's specs can give you the correct frequency values to expect for various devices.

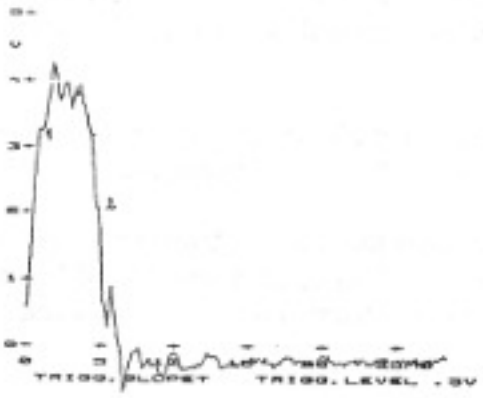
To exit the Lab scope mode press **V** or **kV**.



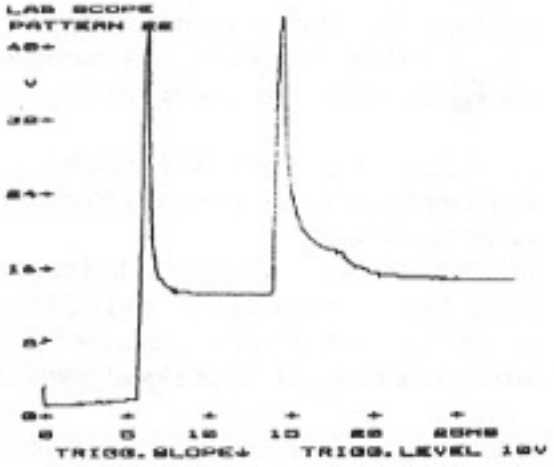
Typical flywheel sensor signal.



Typical inductive sensor signal.



Typical diesel pressure waveform pattern.



Typical Multec injection pattern.

DIESEL OPTION:

The diesel option can be installed in the MEA 1500 SL to add the feature of measuring diesel timing and RPM.
Measurements are made on the VEHICLE TEST page.
The engine electrical measurements are made on the ENGINE ELECTRICAL page.

The optional diesel function is activated by setting the engine mode switch, on the front of the tester, to the 4D position. 4 4D

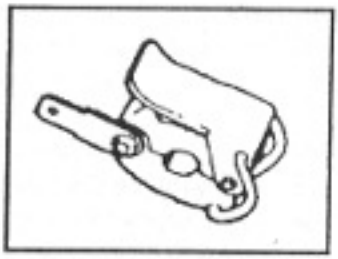
Engine preparation and mounting of the clamp-on transducer:

Select and mount the clamp-on transducer to the injection line of the first cylinder. Observe the following points:

1. The transducer should be mounted as close as possible to the injection pump, but should not touch any parts other than the injection line.

2. Clean the mounting position first. Remove any paint. Remove any unevenness with emery cloth.

3. Select the correct clamp-on transducer;



Blue Transducer for 1/4 " lines.
Grey Transducer for 5.6 mm lines.
Red Transducer for 6 mm lines.
Green Transducer for 7 mm lines.

NOTE: The clamp-on transducer KG 6 (6 mm) supplied as standard with the diesel kit option is suitable for the 6 mm lines.
Clamp-on transducer with other sizes ranging from 4.5mm -12.7 mm are available through your local Sun representative.

4. Only mount the transducer on a straight part of the injection line, NEVER on a bend in the line. If the injection line goes into a bend after the straight part where the transducer is mounted, fit the transducer so that its flat surfaces are parallel with the axis of the curve in the line.

5. Clamp ground clip firmly onto a paint-free part of the injection pump(1)

6. Make sure that none of the cables lie against hot engine parts, such as the exhaust or coolant hoses.

7. DO NOT twist the transducer once it has been clamped-on.

8. Attach push-on terminal of transducer lead to the clamp-on transducer (2) (See Figure 49).

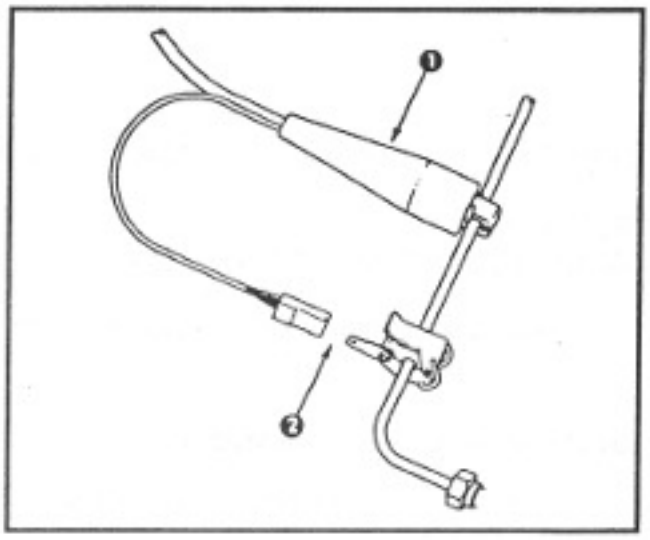


FIGURE 49. Clamp-on connection.

MEASUREMENTS

When the transducer is fitted correctly according to the instructions the engine RPM is displayed after the engine is started, a few seconds after the engine is started the RPM scale will show the idle rpm of the engine. Before adjustments can be made be sure the oil temperature is within the manufacturer's specifications.

Check with the timing light the delivery start angle. Align the rotating mark with the TDC mark, by turning the grey knob of the timing light. (same procedure as for Petrol engines)
The delivery start angle reading is shown at the VDU on the timing reading.
(See manufacturer's specifications to adjust the delivery start angel.)

The start of delivery or the timing on a S.I. engine has almost the same importance for the proper function of the engine. The timing of ignition controls the combustion of the fuel-air mixture in the combustion chamber of a S.I. engine. The diesel engine is more sensitive to changes of the combustion timing than a S.I.engine. In the diesel engine the combustion is controlled by injection of fuel into the highly compressed air in the combustion chamber.

The combustion resp. beginning of injection can be investigated by adequate methods in the laboratories. These methodes are applied for the development of engines.
For the workshops, however, such extensive methods are not applicable. Moreover, at a given pump adjustment (angle adjustment of the pump shaft versus the crankshaft) the start of injection changes within certain tolerances dependent on the tolerances of the injection system, those of the nozzle pressure and even on the coking condition of the nozzle.

Even the combustion at a given start of injection can change within certain limits, dependant of the cetane number of the fuel, the air pressure and the coking condition of the engine. Therefore, it is suggestive for the workshop to use the start of delivery as an adjustment value, as it can be influenced and measured directly.

Before beginning of delivery, there is a certain pressure level in the injection line which is known as residual pressure. At beginning of delivery the pressure at the pump output rises. The pressure wave passes through the injection line with sonic speed . The pressure wave needs a certain period, depending on the length of the lines in order to reach the nozzle. During this time the crankshaft moves at a certain speed for a certain angle, double engine speed means double the angle.

The start of injection is delayed with respect to the beginning of delivery. Expressed in degrees, this delay rises linearily with the engine speed. At a speed of 1000 rpm the delay is 2 degrees, at 2000 rpm it is 4 degrees. Therefore, on multi-cylinder diesel engines all injection lines have the same length and the pumps are equipped with an injection timing device.

It has been mentioned that the diesel engine sensitively responds to the changes of the start of injection. The diagram shows how beginning of delivery affects environmental pollution produced by the diesel engine. However, efficiency data are also strongly influenced by the beginning of delivery , e.g. on a passenger vehicle diesel engine with 60 kW: if beginning of delivery is changed by only 3 degrees crank angle, power drops by 6 kW, torque by 8,9 Nm and the smoke blackening rises.

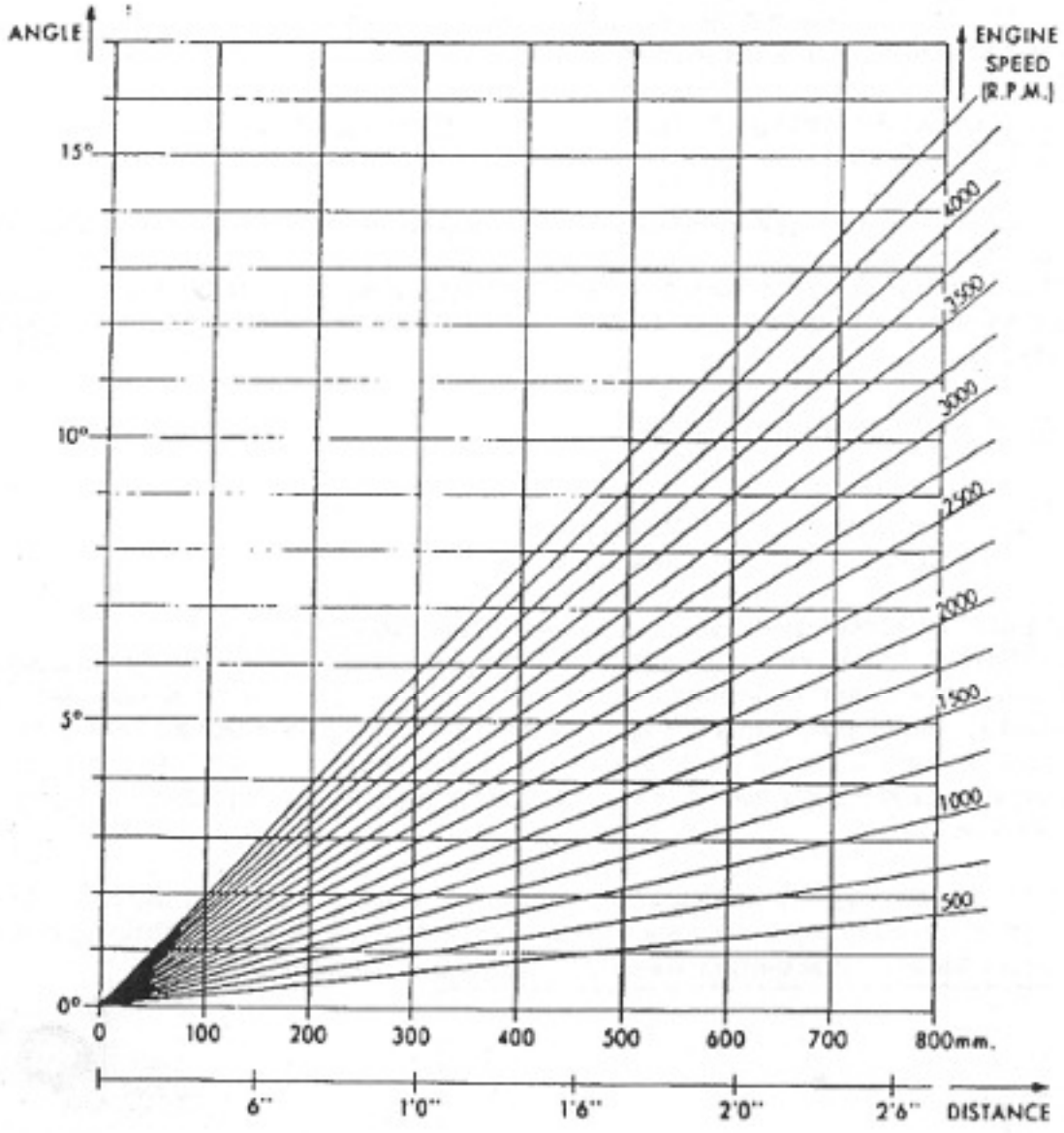


FIGURE 50. Correction Graph for diesel timing.

Check start of delivery timing using the timing light

Start the engine. After a few seconds the RPM scale will show the idle rpm of the engine. Before adjusting the idle settings ensure that the oil temperature is within the manufacturer's specifications.
Using the timing light, check the injection moment. Align the mark on the rotating pulley with the TDC mark by turning the grey knob on the back of the timing light. The timing value is shown on the VDU. Compare this value with the manufacturer's specifications. Adjust if necessary.

Further tests can be performed such as:

- centrifugal advance check.
- RPM drop, by loosening the injector lines one at the time.
- The adjustment of maximum RPM.

The normal check of the starting system, alternator and glowplug functioning are made on the ENGINE ELECTRICAL page.

The MEA 1500 SL has the capability of displaying the signal measured by the transducer on the Enhanced scope.
Connect the VOLT/OHM lead to the red and black banana sockets, on the front of the tester. These sockets are connected to the diesel board in the tester so that the signal from the transducer is connected to the scope.

Set the enhanced scope as follows:

Vertical scale	**: 5 VOLTS**
Time base	**: 25 mS**
Trigger slope	**: POSITIVE**

The picture which is shown on the scope is similar to the picture on this page.
The figure shows the pressure in the injector line. The curve rises at the beginning because the pressure is increasing, until the injector starts to inject the diesel fuel into the cylinder. (At the point marked 1). Then the injector stays open for a certain time, so the pressure decreases. The injector stops injecting at point 2. When the pressure has dropped to a certain level the spring in the injector returns the injector needle to its seating. After that, the pressure drops to the normal system pressure.

The signals of the other cylinders should be similar to one another. To display the other signals the clamp-on has to be clamped onto each injector line in turn. Be sure each clamping place is clean, to avoid damaging the delicate measuring surfaces of the clamp-on.

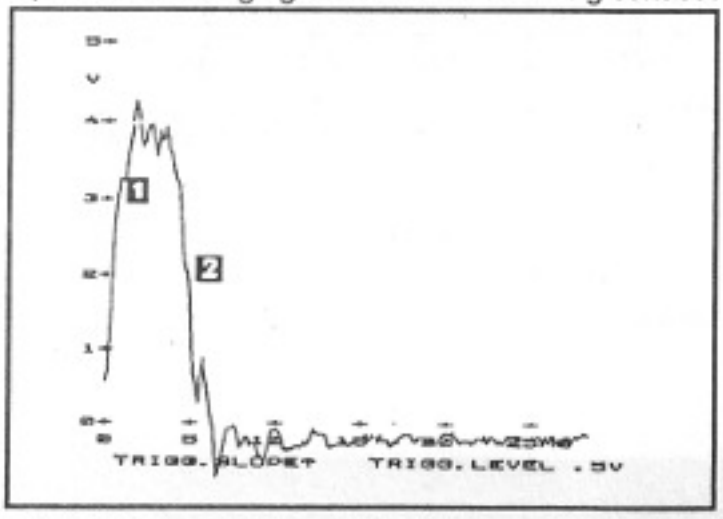


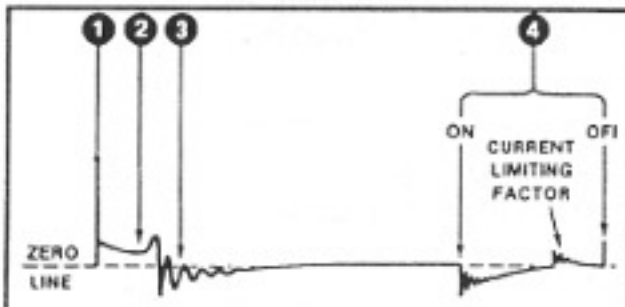
FIGURE 51. Typical diesel pattern on the Lab scope.

IGNITION AND CHARGING SYSTEM SCOPE TESTING

To obtain maximum value from scope testing requires experience, the use of accumulated test data and careful observation of the scope, watching for abnormal patterns. To enable the operator to recognize abnormal patterns, Figure 52 illustrates normal patterns for various ignition systems as points of comparison.

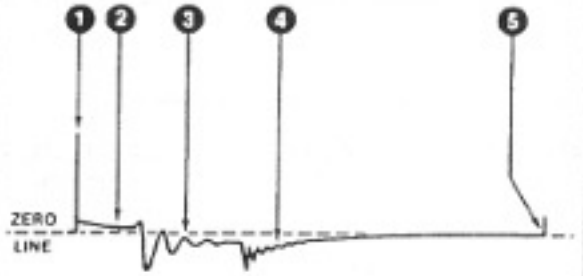
The presence of abnormal patterns may indicate the need to perform one or more of the tests from the charts in this section. Be sure to use the correct chart (electronic or breaker point) when performing tests.

NOTE: Sun has produced a manual entitled "Understanding Automotive oscilloscope Patterns", which is a complete description of how to perform scope tests and how to interpret the results. Consult your local Sun sales representative for details.



TYPICAL ELECTRONIC IGNITION SYSTEM PATTERN.

1. **Firing line** from 7 to 18 kV with no more than 3 kV variation. Tests plug and rotor gap, broken wires and fuel mixture.
2. **Spark line** - with PATTERN SELECTOR in 5 mSec position, spark duration should not be less than 0.8 mSec nor more than 2.0 mSec, approximately 1.5 mSec preferred. The line should be level between 2 and 4 kV. Tests plugs, wires, cap, rotor or engine condition affecting plug firing. Should diminish gradually.
3. **Intermediate oscillations** should diminish gradually if coil is not shorted.
4. **Transistor opening** and closing indicates points at which transistor turns on and off. Tests control module and pick-up coil in distributor cap.
5. Current limiting (on systems having saturation current limiting) tests for module condition and for high primary circuit resistance.



TYPICAL BREAKER POINT IGNITION SYSTEM PATTERN

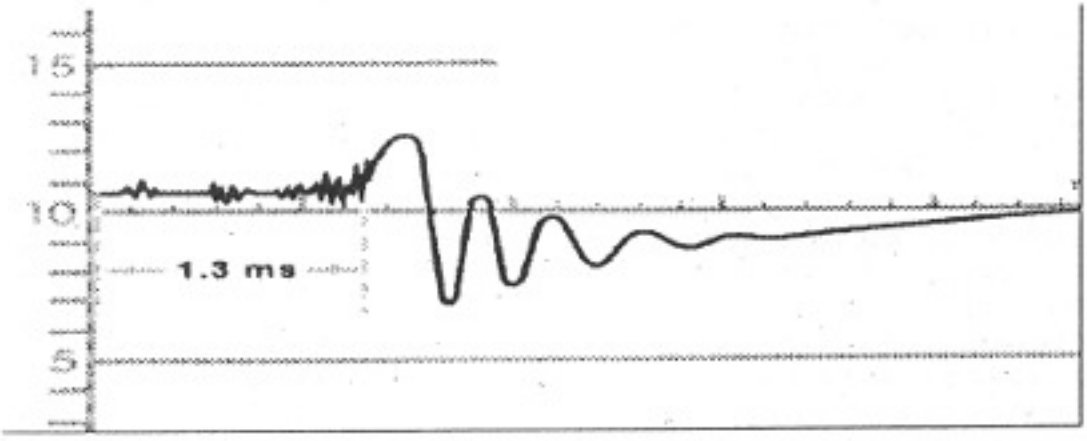
1. **Firing line** from 5 to 15 kV with no more than 3 kV variation. Tests plug and rotor gap, broken wires and fuel mixture
2. **Spark line** straight and level starting at 2 kV or less. Tests plugs, wires, cap, rotor or engine condition affecting plug firing.
3. **Intermediate oscillations** test for coil, condenser or primary circuit defects.
4. **Point closing**, short downward line followed by small oscillations. Tests for point condition and point spring tension.
5. **Point opening**, abrupt 90^0 angle to begin next firing line. Tests for pitted points or arcing caused by poor condenser action.

FIGURE 52. Typical Ignition System Patterns.

OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Spark Duration test **NOTE: This test can be performed either during cranking or running. The cranking test is usually done on an engine which will not start.**	To determine if the spark duration is acceptable.	1. Set pattern to ms 2. Set circuit to kV 3. Set scale to 0-25 kV 4. Crank engine and **quickly** read spark duration.

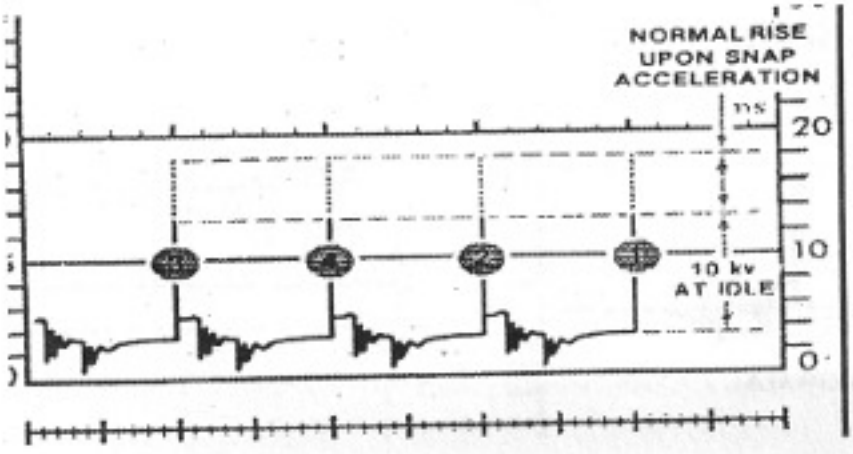
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Spark duration should be between 0.8 and 2.0 mSec. About 1.5 mSec is preferred.	Duration **too short:** 1. High resistance primary 2. Low coil output 3. Rotor gap too wide Duration **too long:** 1. Fouled spark plug 2. Low compression 3. Spark plug gap too small



OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Spark plug firing voltage.	To determine if plug firing voltage is within normal limits.	1. Start the engine and operate at 1000 to 1500 rpm 2. Set circuit to kV 3. Set scale to 0-25 kV. 4. Set pattern to ⌇⌇ 5. Note firing line amplitude and position.

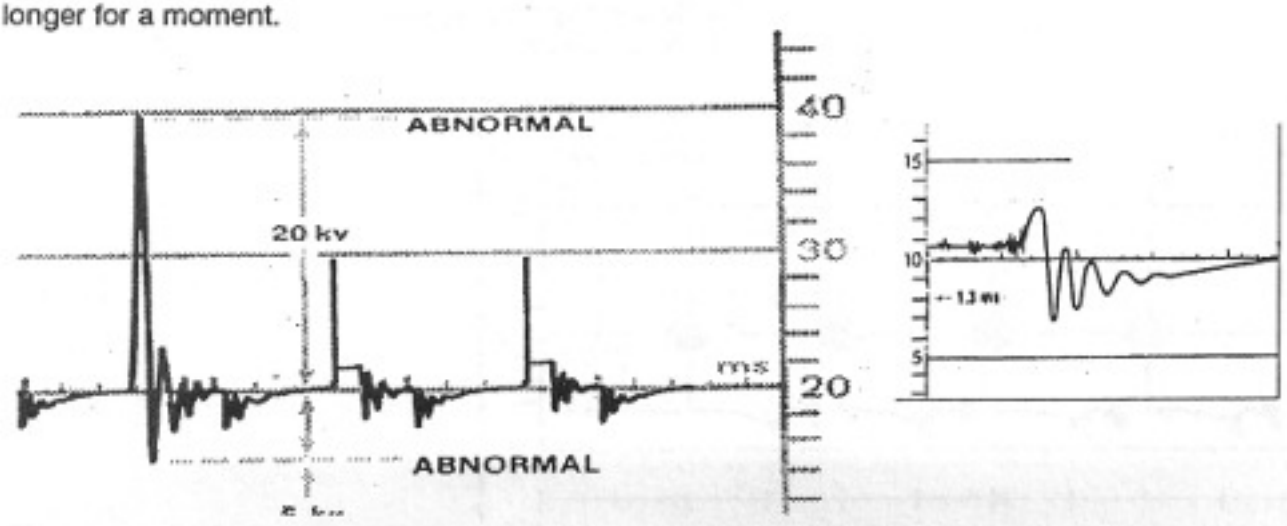
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Observe firing lines for all cylinders. Firing lines should be between **7** and **18** kV with no more than a **3** kV variation between cylinders.	If firing voltages are **uneven (some high):** 1. Worn spark plugs 2. Breaks in spark plug wires 3. Worn distributor cap 4. Vacuum leaks If firing voltages are **even, but too high:** 1. Open high tension coil wire 2. Worn spark plugs 3. Rotor gap too wide 4. Retarded ignition timing 5. Fuel mixture too lean 6. Faulty distributor cap 7. Rotor resistance too high If firing voltages are **uneven(some low):** 1. Low compression 2. Fouled spark plug 3. Incorrect plug gap 4. Shorted spark plug lead 5. Spark plug insulator cracked



OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Secondary insulation	Locate secondary circuit insulation breakdowns.	1. Operate engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set pattern to bb 4. Set scale to 0 - 25 kV 5. Connect one end of a jumper lead to ground and the other end to the large portion of the resistance test contactor. (Sun P/N 4344-0000) 6. Run the test contactor all over the following components while observing firing lines on scope. a. Coil tower b. Coil high tension wire and boots. c. Distributor cap and terminals d. Spark plug wires and boots

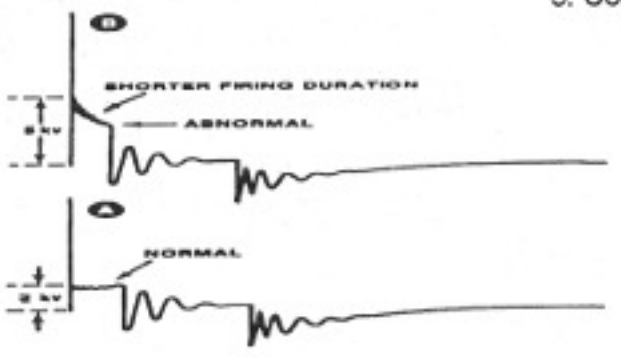
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
If an insulation breakdown occurs, firing lines will decrease in height, and spark duration will be longer for a moment.	Replace items having faulty insulation

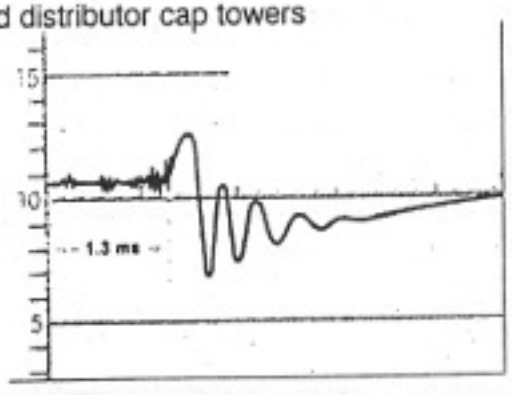


OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Secondary ignition circuit resistance.	Determine acceptability of secondary circuit resistance by inspection of spark line slope.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set pattern to hh 4. Set scale to 0 - 25 kV 5. Connect one end of a jumper lead to ground and the other end to the large portion of the resistance test contactor. (Sun P/N 4344-0000) 6. Run the test contactor all over the following components while observing firing lines on the scope. a. Coil tower b. Coil high tension wire and boots. c. Distributor cap and terminals d. Spark plug wires and boots

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
A good spark line should be between **2** and **4** kV and should be relatively level. a. Spark line should begin lower than before and will be longer than **2.5** mSec.	1. Burned rotor tip 2. High resistance plug lead 3. Distributor cap segments burned 4. Faulty spark plug 5. Corroded distributor cap towers

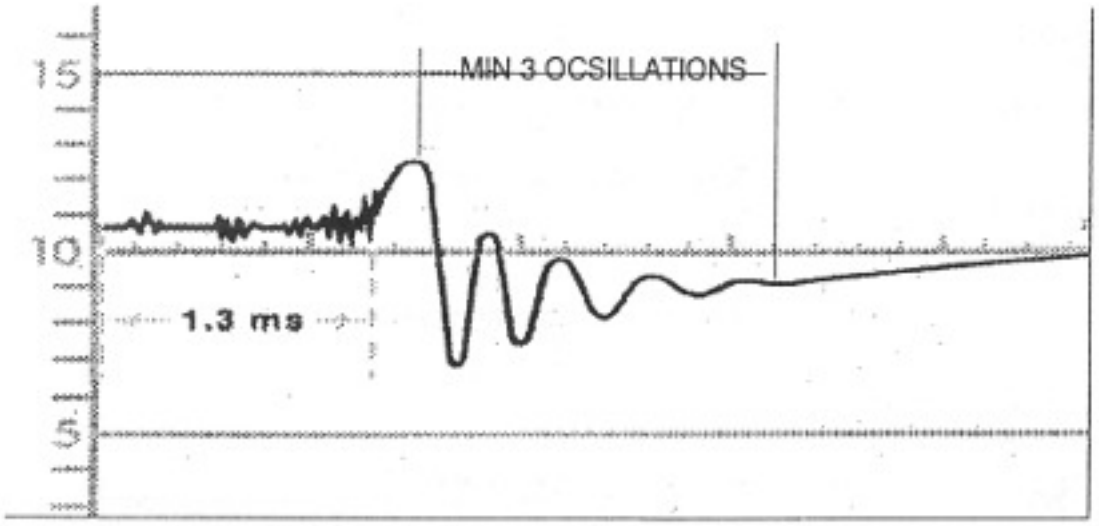




OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Coil condition **NOTE: This test is not valid for Chrysler EIS systems.**	Determine if coil is in good condition by inspection of oscillations in intermediate section of secondary pattern.	1. Operate the engine at 1000 to 1500 rpm. 2. Set pattern to R 3. Set circuit to V or kV 4. Observe intermediate section of waveform. a. Or short the spark lead tower at the distributor cap for a moment with the test contactor to ground.

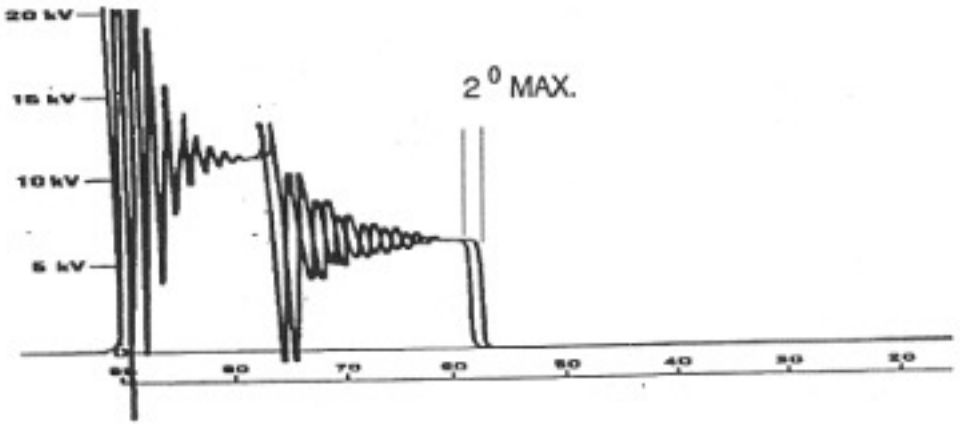
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Oscillations in the intermediate section should gradually diminish. a. The spark line should be over 2.5 mSec and starts about 0.3 kV lower than normal.	1. Shorted coil



OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Cylinder timing accuracy.	Determine if all cylinders are firing in the same relationship to TDC.	1. Operate the engine at 1000 to 1500 rpm. 2. Set pattern to h 3. Set circuit to V or WAV 4. Observe the transistor turn-off area of the waveform.

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
4 cyl. engine - not to exceed 2% (2 degrees) **6 cyl. engine** - not to exceed 4% (2 degrees) **8 cyl. engine** - not to exceed 6% (2 degrees) **NOTE: The above is an approximation since it is impossible to see scope variations of less than one degree with complete accuracy.**	1. Bent distributor shaft 2. Worn distributor bushings 3. Worn distributor drive gear 4. Worn camshaft gear 5. Worn timing chain



OSCILLOSCOPE TESTING - IGNITION TESTING - ELECTRONIC SYSTEMS.

TEST	PURPOSE	TEST CONDITIONS
Module condition	Determine if module is in normal condition.	1. Operate the engine at idle. 2. Set pattern to  3. Set circuit to  or 4. Observe the transistor turn-on area of the waveform.

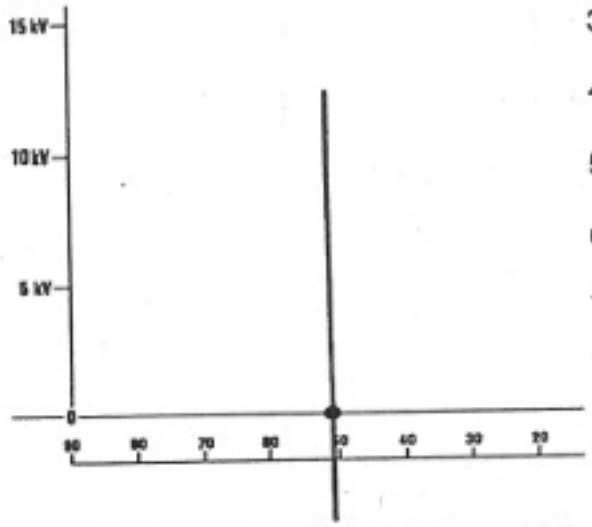
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Turn-on position should increase when the rpm is brought up to 3000 rpm.	1. Check for good engine ground 2. If ground is good replace module

OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Coil output while cranking.	Verify efficient functioning of primary circuit and coil (usually performed when vehicle would not start or is hard to start).	1. Disconnect the coil secondary lead from the center terminal of the distributor cap. Do not use the button or key. 2. Set circuit to 3. Set scale to 50 kV 4. Set pattern to 5. Crank engine with ignition key ON. 6. Record maximum rise of waveform. 7. Stop cranking and reconnect the coil lead.

NOTE: Observe manufacturer's recommendations concerning open circuit testing.

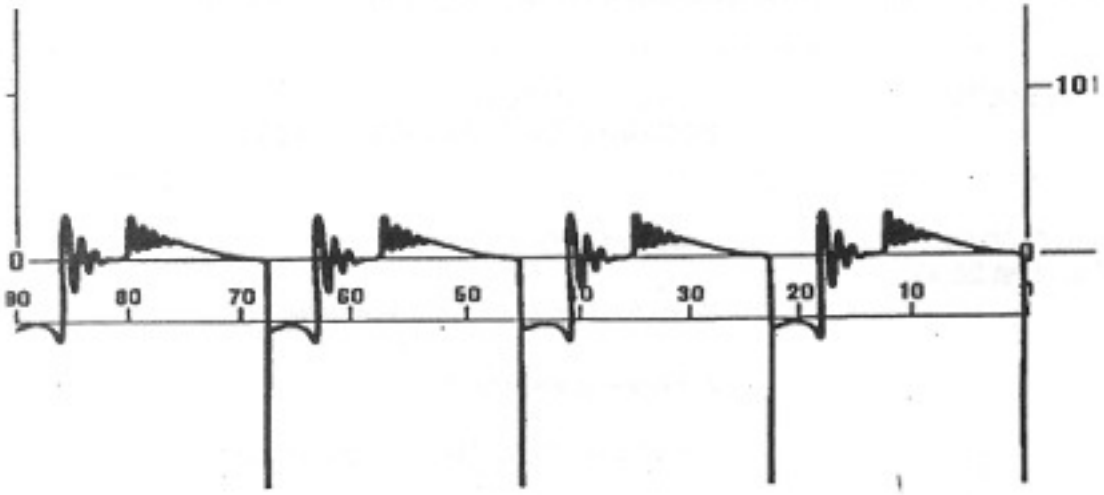
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Should produce secondary circuit spikes of at least 20 kV.	1. Battery voltage low 2 . Excessive starter current draw 3. Faulty ignition switch 4. Failure of ballast resistor bypass circuit 5. Incorrect dwell 6. Excessive distributor resistance 7. Faulty coil or condenser 8. Faulty coil wire 9. Faulty primary connection.



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Coil polarity	Determine if coil is delivering secondary voltage of correct polarity.	1. Start engine. Operate engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set scale to low 4. Set pattern to ▷ 5. Note firing line amplitude and position.

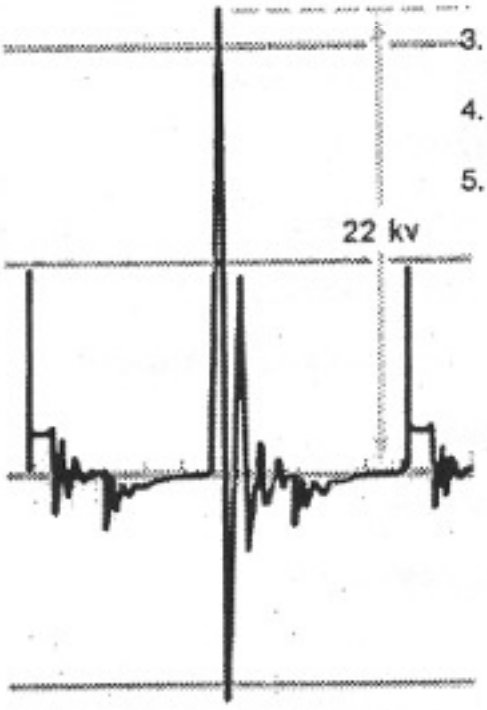
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Firing line should point up. If it points down, polarity is reversed.	1. Reverse primary connections at the coil.



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Maximum coil output voltage (running).	Verify overall condition of ignition system by raising voltage to maximum.	1. Operate engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set scale to 50 kV. 4. Set pattern to hh 5. Use insulated pliers to disconnect one spark plug wire. Hold it away from engine ground. 6. Record maximum rise of firing line on the 50 kV scale. 7. Reconnect spark plug wire

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
The coil should produce a minimum voltage of **20 kV.**	1. Faulty coil 2. Dwell out of limits. 3. Excessive primary circuit resistance 4. Faulty secondary insulation 5. Low primary voltage

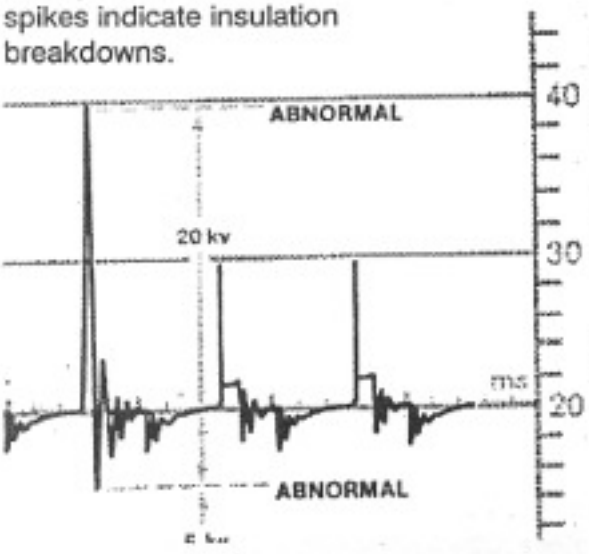


NOTE: Observe manufacturer's recommendations for removing spark plug wires with engine running.

OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Secondary circuit insulation	Locate secondary ignition system insulation breakdowns.	1. Operate engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set scale to 50 kV. 4. Set pattern to ⌇ 5. Use insulated pliers to disconnect one spark plug wire. Hold it away from engine ground 6. Record maximum rise of firing line on the 50 kV scale. 7. Record maximum down-spike of waveform on 50 kV scale. 8. Reconnect spark plug wire

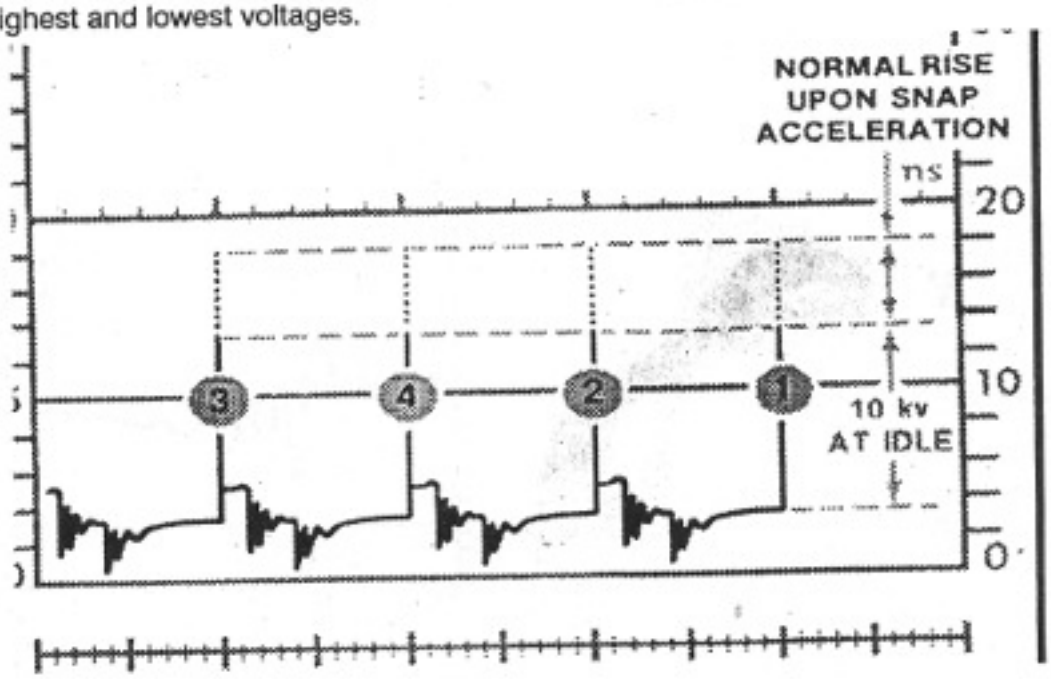
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
The downward extension of the firing line should be 1/2 of the upward extension of the firing line. Absence of a spike or intermittent spikes indicate insulation breakdowns.	If fault occurs in **some** cylinders: 1. Faulty distributor cap 2. Faulty spark plug wires. If fault occurs in **all** cylinders: 1. Cracked or carbon tracked coil tower 2. Faulty rotor 3. Faulty coil wires 4. Faulty distributor cap



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Spark plug firing voltage.	Determine if firing voltage are within normal limits.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set scale to 25 kV 4. Set pattern to ⊓ 5. Note the firing line amplitude and position.

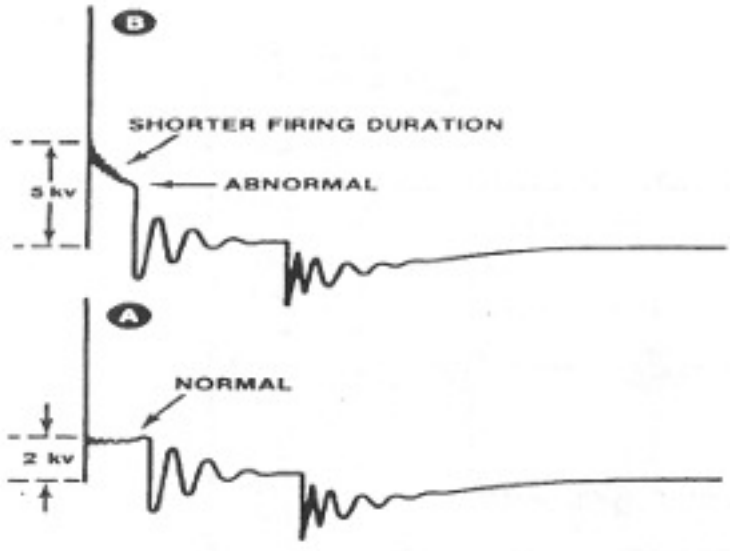
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
Firing lines for all cylinders should be uniform within **3 kV** and should be between **5** and **15 kV** If some spikes are higher see causes. When dyno testing under load, firing voltages may increase **2** to **4 kV** over no load. Record highest and lowest voltages.	1. Worn spark plugs 2. Faulty spark plug leads 3. Worn distributor cap 4. Vacuum leaks

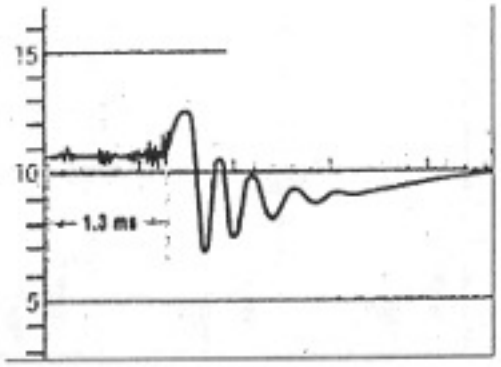


OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Secondary circuit resistance.	Determine if secondary resistance is abnormally high.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to kV 3. Set scale to 25 kV 4. Set pattern to ▮ 5. Note the appearance of each waveform spark line.

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
The spark line should be level and measure **2** to **4 kV.** A sloping spark line which begins at a voltage higher than **4 kV** and has a shorter than normal duration is abnormal.	1. Rotor tip burned 2. High resistance spark plug wire 3. Distributor cap terminals burned 4. Faulty spark plug

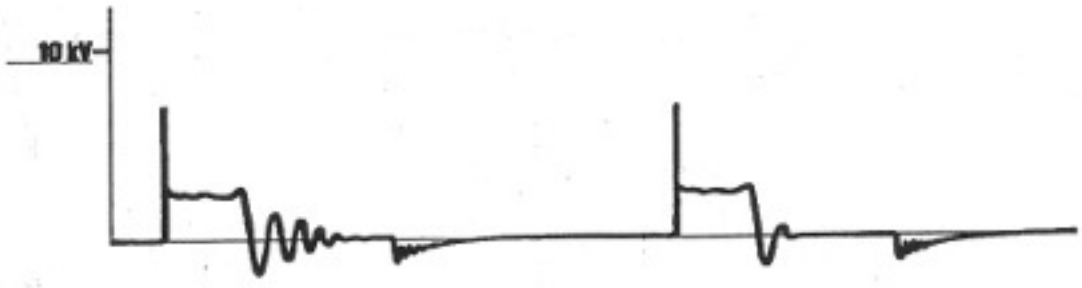




OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Coil and condenser	Determine condition of coil and condenser.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to V or KV 3. Set scale to low 4. Set pattern to h 5. Observe point open and point close portion of dwell section.

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
The intermediate section of primary and secondary patterns should be a series of gradually diminishing oscillations.	1. Shorted coil 2. Leaky condenser 3. High resistance lead or poor connection to condenser.



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

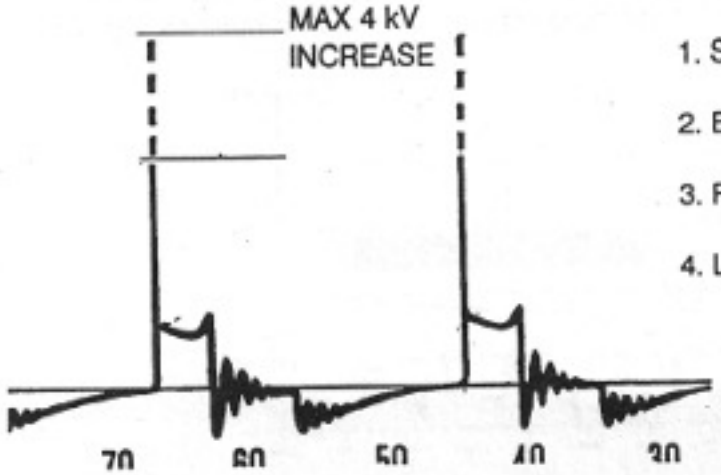
TEST	PURPOSE.	TEST CONDITIONS
Breaker points	Determine condition of breaker points, condenser and distributor cam.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to V or kV 3. Set scale to low. 4. Set pattern to ⊓ 5. Observe intermediate section waveform for gradually diminishing oscillations.

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
The point close section of the primary waveform should be a short straight downward line. In the secondary, the line should be followed by a few small oscillations. Spikes above the point close kV line or sloping/ oscillating point closing lines are abnormal.	1. Breaker point spring tension too weak. 2. Excessive distributor vibration 3. Worn or corroded distributor cam 4. Pitted, misaligned, burned or high resistance points. 5. Defective condenser

OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Ignition system condition under load (snap acceleration).	Determine individual spark plug performance under load.	1. Operate the engine at idle speed. 2. Set circuit to kV 3. Set scale to high 4. Set pattern to 5. Snap accelerate engine to approx. 2000 rpm. Then release throttle. 6. Note and record the minimum and maximum rise of the firing lines on the 50 kV scale.

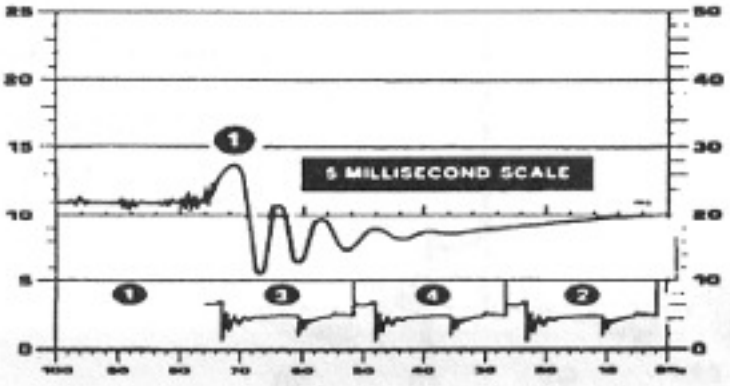
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
All plug firing lines should increase moderately and uniformly. No individual spark line should be extremely high or low in relation to the average.	If firing voltage **too high:** 1. Spark plug cap too wide 2. Worn spark plug electrodes 3. Open spark plug wire 4. Improper fuel mixture 5. Open spark plug resistor 6. Vacuum system leaks If firing voltage **too low:** 1. Shorted spark plug wire 2. Broken spark plug insulator 3. Fouled spark plug 4. Low compression.



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Cylinder pattern comparison test.	To enlarge an individual cylinder waveform for comparison with others.	1. Operate the engine at the desired test speed. 2. Set circuit to V or kV 3. Set scale to high. 4. Set pattern to bh 5. Select the cylinder to be compared and press the corresponding keypad number. 6. Compare the enlarged waveform to the others being displayed. 7. Press CE to return to initial state. 8. Repeat above procedure to compare other cylinder waveforms. 9. Select two ore more keypad numbers. These waveforms will be shown superimposed at the top of the scope.

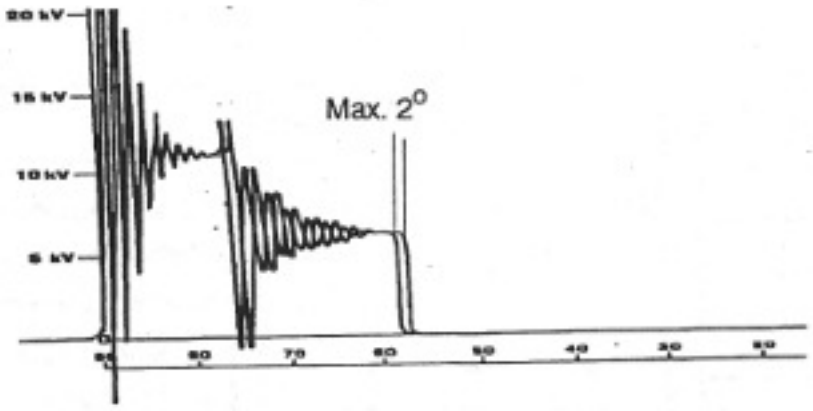
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS -. POSSIBLE CAUSES AND REMEDIES.
This test is primarily to determine whether or not individual waveforms deviate from the norm.	If one or more waveforms is substantially different from the rest,select and perform the scope test in this series of tests which will pinpoint the problem.



OSCILLOSCOPE TESTING - BREAKER POINT SYSTEM.

TEST	PURPOSE	TEST CONDITIONS
Cylinder timing accuracy.	Determine if all cylinders are firing the same relationship to TDC.	1. Operate the engine at 1000 to 1500 rpm. 2. Set circuit to V or kV 3. Set scale to low. 4. Set pattern to ⊓ 5. Record any misalignment (in degrees) of waveform point open patterns.

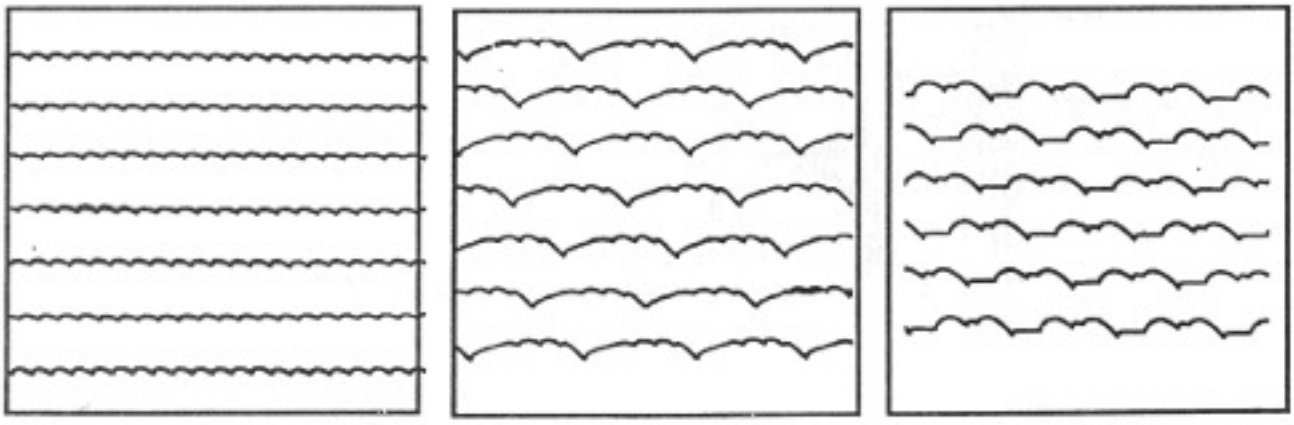
NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
4 cyl. engine - not to exceed 2% (2 degrees) **6 cyl. engine** - not to exceed 4% (2 degrees) **8 cyl. engine** - not to exceed 6% (2 degrees) **NOTE: The above is an approximation since it is impossible to see scope variations less than one degree with complete accuracy.**	1. Bent distributor shaft 2. Worn distributor bushings 3. Worn distributor drive gear 4. Worn camshaft gear 5. Worn timing chain 6. Worn distributor cam lobes



OSCILLOSCOPE TESTING - ALTERNATOR TEST - ALL SYSTEMS

TEST	PURPOSE	TEST CONDITIONS
Alternator ripple pattern	Detect defective alternator	1. Set pattern to  2. Set circuit to  3. Place the GREEN pick-up around the alternator output (+) lead or the positive battery cable. 4. Start the engine and operate at approx.1000 rpm. 5. Turn the headlights on and on high beam. 6. Observe the waveform and compare to the test result column.

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
A normal alternator output pattern is a series of waveshaped ripples of the same height and spacing. Under no load conditions, the waveform will have uniform spikes and peaks Abnormal waveforms will be uneven and jagged.	Faulty alternators must be removed from the vehicle for repair.

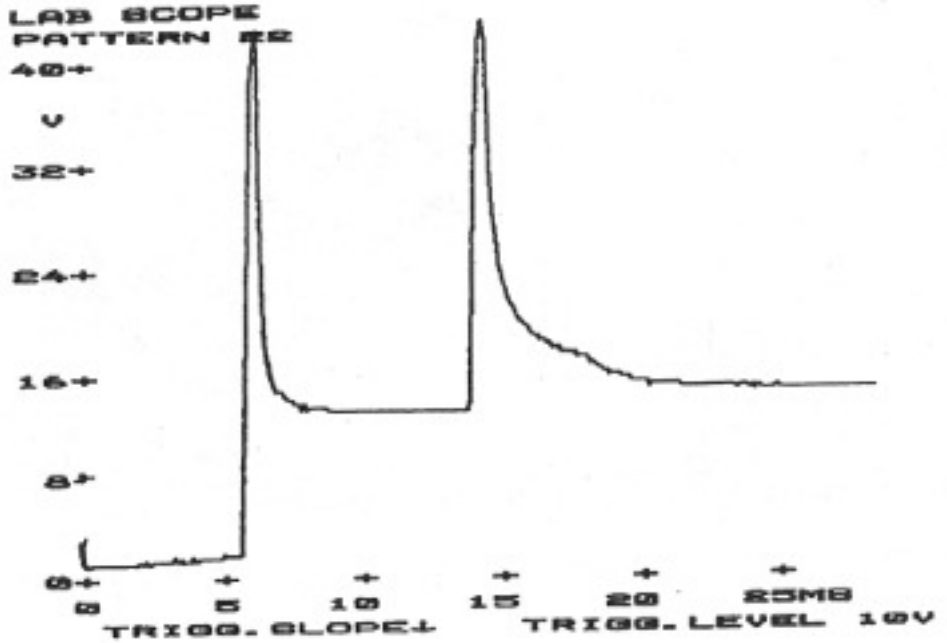


Normal Alternator *Open Diode* *Shorted Diode*

OSCILLOSCOPE TESTING - ENHANCED SCOPE - ELECTRONIC PARTS

TEST	PURPOSE	TEST CONDITIONS
Adjustment or control	Verify effective functioning of the electronic component.	1. Press the key twice 2. Connect the volt/ohm leads to the subject 3. Start the engine 4. Press the key until the signal is steady (triggering) 5. Press the key if the polarity is incorrect 6. Press the key for other time scale 7. Note the amplitude

NORMAL TEST RESULTS	ABNORMAL TEST RESULTS - POSSIBLE CAUSES AND REMEDIES.
A steady waveform with the first line upwards. Depends on which electronic component is being tested.	See manufacturer's specifications



PRINTER OPERATION AND MAINTENANCE .

General Description

The MEA-1500 SL optional printer (AP 1000-1) is installed to provide service shops with actual proof of tests performed on vehicles serviced. Installation and set-up of the printer is provided by SUN service personnel.

Perforated print paper, divided into 9 1/2" x 11" sections(P/N 0528-0994), is bottom-fed into the printer from a paper storage compartment. Replacement ribbon cartridges(P/N 0528-0995) install easily.

Printer Controls

NOTE: All controls on the front of the printer (Figure 53) should be disregarded since all printer functions are performed automatically through the MEA remote control keypad upon installation and power-up.

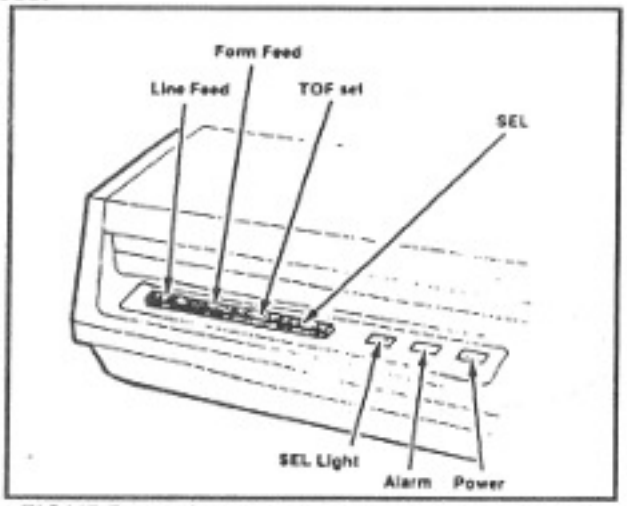
Pressing the printer buttons may affect the printer operation.

The three indicator lights on the printer front panel (Figure 53) do provide the operator with useful data.

SEL light- The SEL light indicates communications with the MEA-1500 SL. The light must be on for the printer to operate.

ALARM - The ALARM lights when the paper is out. Printing stops until paper supply is replenished. The VDU will also give an indication of empty paper supply.

The ALARM also lights when the printhead becomes jammed or stopped during the printing process.



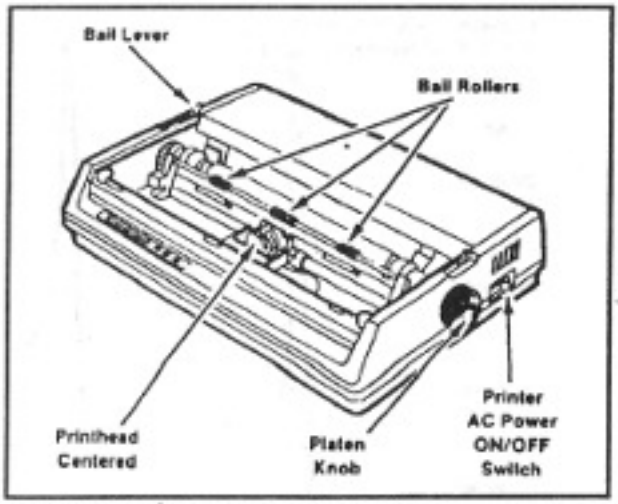


FIGURE 53. Front Panel Buttons and Indicators. FIGURE 54. Location of Controls.

POWER - The POWER light indicates that the AC switch (Figure 54) is on and the printer is powered up.

The printer also has integral factory-set switches that must not be altered or re-set in any way. The rear cover of the printer should not be removed.

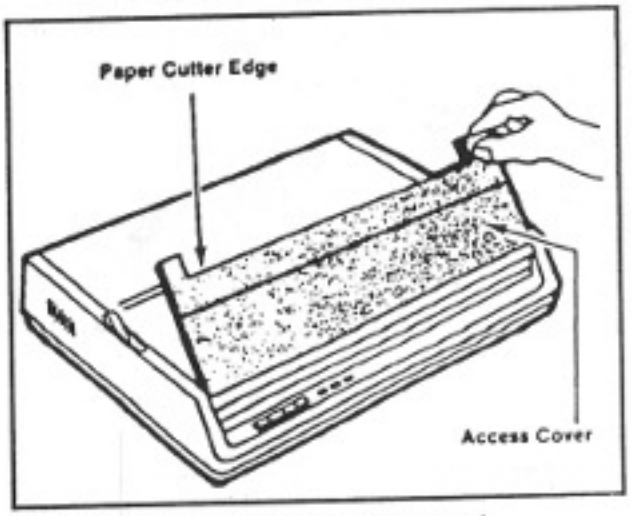


FIGURE 55. Access Cover Removal.

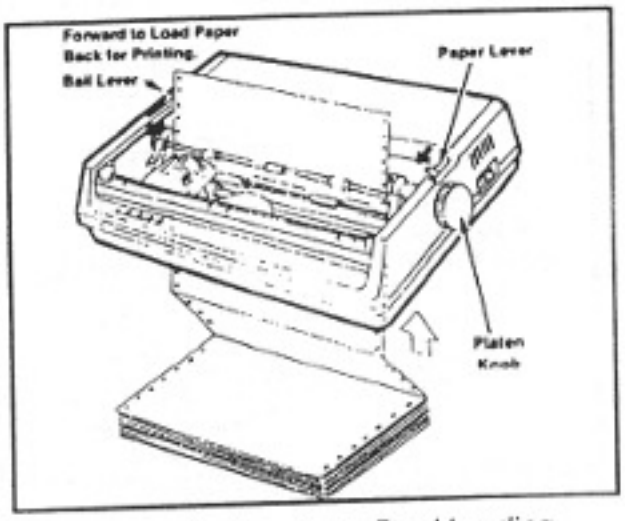


FIGURE 56. Bottom Paper Feed Loading.

Paper loading.

1. Turn the printer AC switch (Figure 54) to PRINTER OFF. (POWER indicator light OFF)
2. Remove the printer access cover (Figure 55) by lifting it off.
3. Place the stack of print paper in the compartment below the printer.

   NOTE: Only one-part paper perforated into 9 1/2" x 11" sections with pin feed holes (Sun P/N 0528-0994) should be used.
4. Lift the bail.(Bail lever forward). The paper lever should be open (forward). Refer to Figure 56.
5. Take the first sheet of paper and feed it through the bottom of the printer and into the paper guides, as per Figure 56.
6. Align and mount the holes of the paper with the corresponding pins (Figure 57).

   NOTE: Adjustable pin feeds should always be set to accommodate 9 1/2" width print paper (P/N 0528-0994). If for some reason pin feed width is not set at 9 1/2", re-set by pushing the pin feed adjustment levers (located just to the outside of each set of pins) forward and sliding the mechanism(s) to the correct 9 1/2" width. Push adjustment levers back into place to lock mechanism in new position. Refer to Figure 56.
7. Lower the bail and replace the access cover.
8. Turn printer power switch back ON. (POWER indicator light and SEL light ON).
9. Press [ ] on the MEA remote keypad twice quickly. Paper will automatically advance "one" form.
10. After the paper stops advancing, advance the paper manually with the platen knob until a perforation is lined up with the tear-off edge of the printer access cover.

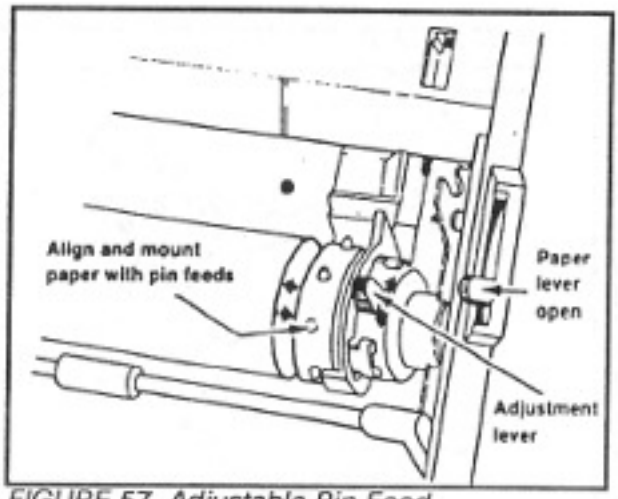


FIGURE 57. Adjustable Pin Feed.

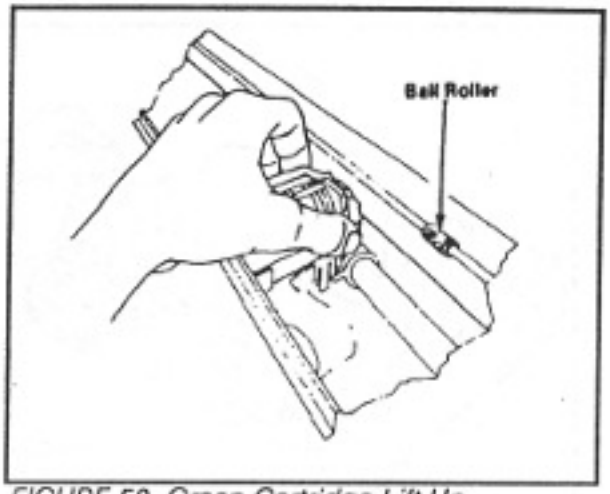


FIGURE 58. Grasp Cartridge Lift Up.

Printer Maintenance.

Ribbon cartridge replacement.

1. Turn the printer AC power switch OFF (POWER indicator light OFF).
2. Remove the printer access cover.
3. Gently slide the printhead to the middle of the printer (Figure 54).
4. To remove the old ribbon cartridge, grasp it on either side of the printhead and lift up (Figure 58).
5. Install the new black ribbon cartridge (P/N 0528-0995) by inserting the cartridge on to the printhead plate.

   To insert the cartridge on the printhead plate, tilt the side of the cartridge opposite the ribbon shield so that portion of the cartridge slides on to the front of the printhead plate. Lower the top of the cartridge containing the side with the ribbon shield over the printhead. See Figure 59. (Do **not** remove the ribbon shield.) A tab on each side of the cartridge will align perfectly with inserts on the printhead plate (Figure 60)

6. Press gently on the cartridge until it snaps into place (Figure 61).

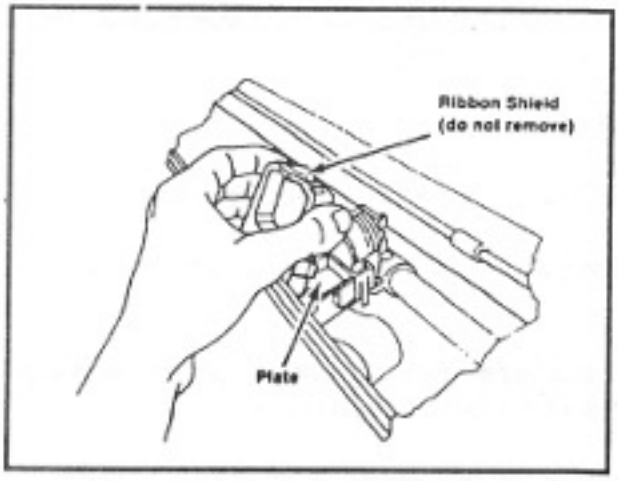


FIGURE 59. Installing Ribbon Cartridge.

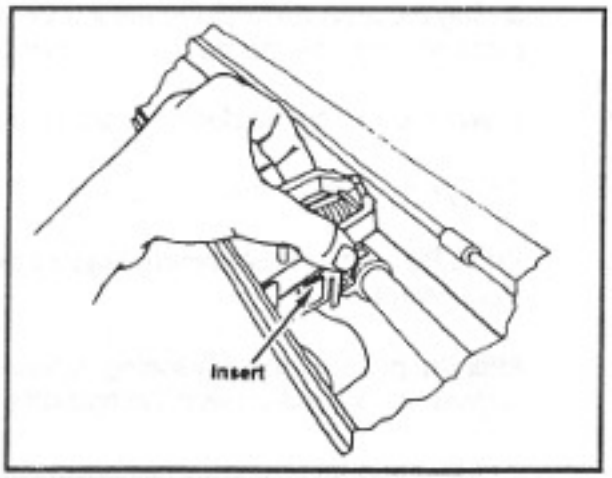


FIGURE 60. Installing Ribbon Cartridge.

7. Be sure the blue printhead gap lever, located to the left of the ribbon cartridge (Figure 62), is set in the number one (1) position.

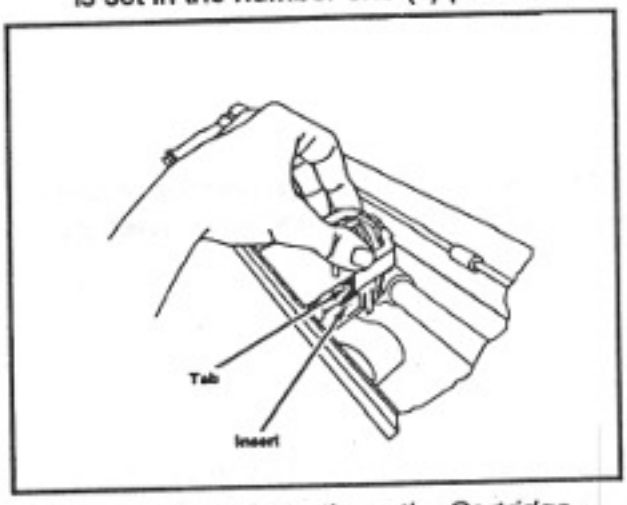


FIGURE 61. Press gently on the Cartridge.

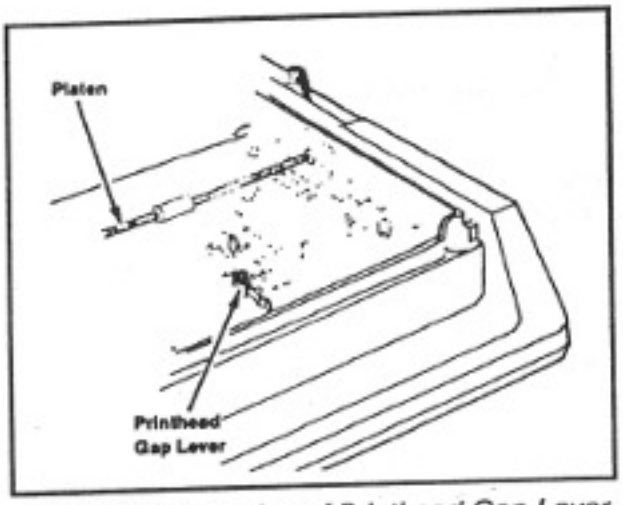


FIGURE 62. Location of Printhead Gap Lever.

Basic troubleshooting

Basic settings and control should be checked before calling for SUN service:

1. The AC power switch on the printer must be turned on, as indicated by the lit POWER light on the front panel.
2. Printer must be in SEL mode, indicated by the SEL light on the front panel.
3. Bail lever should be positioned toward the back of the printer during operation. (Rollers should be in contact with paper). Paper lever should be positioned toward the front of the printer.
4. Blue printhead gap lever should be in number one(1) position.
5. The ALARM light should be OFF. If the ALARM indicator is ON, check to see if paper supply is full and loaded properly and also check to see if printhead is jammed or stopped.

Routine maintenance

For trouble-free operation, the printer should be cleaned as follows at least once a month (or after 300 hours of operation):

NOTE: Do not apply any lubricants to the printer.

1. Turn off the AC power of the printer. Remove paper from printer.
2. Remove the printer access cover.
3. Using a clean, dry, soft cloth, dust the area around the carriage shaft, platen, and paper sensors. Remove any loose paper particles or other debris.
4. With the nozzle attachment of a vacuum cleaner, vacuum the carriage shaft and paper feeding areas very carefully to remove any accumulated dust. Do not use a compressed air supply.

5. Re-load paper (see "Paper Loading") and replace the access cover.

Printer Operation

Before operating the printer, verify that the paper has been loaded correctly and the proper indicators are lit as described in " Printer Controls". Also check that bail lever and paper lever are set as shown in Figure 56.

Setting Top of Form

1. At printer power-up, always **manually** set top-of-form (TOF). This is done by advancing the paper with the platen knob until a perforation is lined up with the tear-off edge of the printer cover.

   NOTE: Do not attempt to use the TOF SET and FORM FEED buttons on the printer. The MEA - 1500 SL automatically controls the printer. Pressing these buttons may adversely affect the printer operation.

Printing

2. To print a VDU page, simply press the key on the remote keypad. After a momentary pause, information presented on the VDU will be printed and several blank lines will be added to separate the next printed page. The indicated prompts on the VDU will **not** appear on the printouts.

Removing a page

3. After a page has been printed, press key twice quickly. The paper will automatically advance until the next perforation is aligned with the tear-off edge of the printer access cover.

   NOTE: If the perforation does not align with the edge of the printer cover, manually turn the platen knob until the perforation is in line.

4. Tear the paper off against the edge of the printer cover.

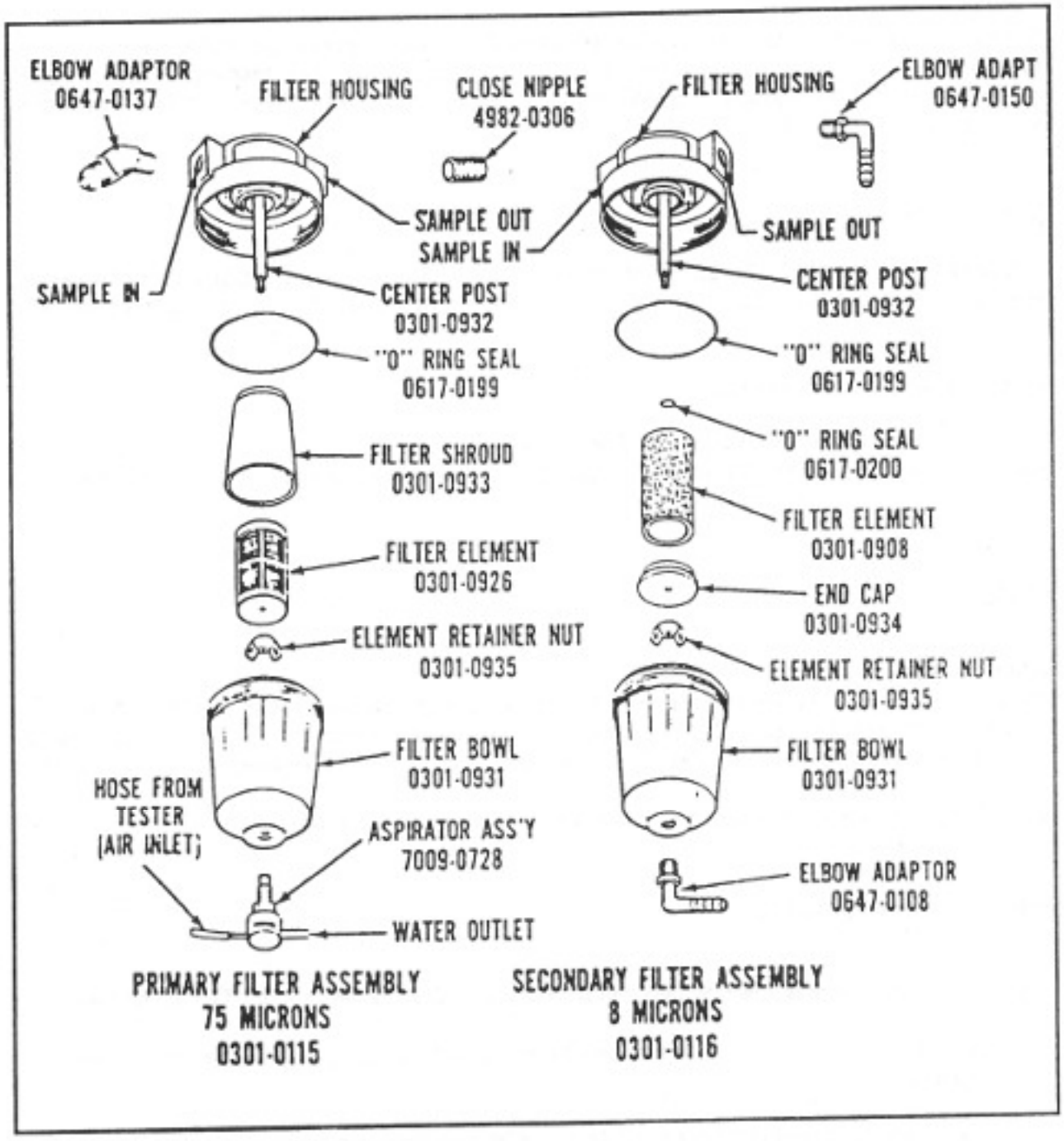


FIGURE 63. Sample Filter Arrangement

MAINTENANCE and SERVICE

General

The maintenance and service procedures for the MEA-1500 SL presented in this section are those in which the operator can perform. All other service should be performed by an authorized Sun representative. If an emissions module option is not installed, the filter and sample probe maintenance procedures are not applicable.

Sample Hose Maintenance

Periodically inspect the SAMPLE HOSE for any signs of damage such as leaks, cuts, and kinks. Also, check sample hose connections for tightness. Replace hose if leaks are found or suspected.

Sample Probe Maintenance

Frequently inspect the SAMPLE PROBE for damage. Check for clogged holes in the probe tip. If the holes are found to be clogged, use a piece of stiff wire or other suitable object to dislodge and remove any foreign matter.

Filter Maintenance

When to service

The primary and secondary filters should be replaced or cleaned when the LOW FLOW message appears. Before replacing or cleaning the filters, however, it is recommended that the sample probe be serviced and/or cleaned. Then, if the response time is still slow, clean or replace the filters.

A label explaining filter maintenance and installation is on the back of all testers.

Primary Filter Service

The primary filter element may be cleaned or replaced. Service the primary filter as follows:

1. Disconnect the water outlet and air inlet hose from the fitting on the filter bowl. See Figure 63.

2. Unscrew the filter bowl from the filter housing by turning the bowl counterclockwise.

   CAUTION: When removing the filter bowl, be careful not to damage the "O" ring at the top of the bowl.

3. Turn the element retainer nut counterclockwise and remove the filter element.

4. Wash out the bowl and filter element in a mild soap and water solution. Allow the bowl and element to dry before reassembling.

5. Reassemble the primary filter in reverse order of disassembly.

NOTE: Be sure the "O" ring is properly positioned in the groove of the filter bowl.

6. Reconnect the water outlet and air inlet hoses.

Secondary Filter Service

The secondary filter element must be replaced when it becomes dirty or clogged. Service the secondary filter as follows:

1. Disconnect hose from the elbow adapter. See Figure 63.
2. Unscrew the filter bowl from the filter housing by turning the bowl counterclockwise.

   CAUTION: When removing the filter bowl, be careful not to damage the "O" rings.
3. Turn the element retainer nut counterclockwise and remove the end cap.
4. Remove and discard the old filter element.
5. Wash out the filter bowl in a mild soap and water solution, then allow to dry.
6. Install a new filter element.
7. Reassemble the secondary filter in reverse order of disassembly.

   NOTE: Be sure the "O" rings are properly positioned during assembly.

Air Filters

The foam filter elements fitted to power supply and gas drawers must be cleaned weekly.

Maintaining Tester Finish

The Modular Engine Analyzer has a finish of stain resistant baked enamel and brushed aluminum. It is recommended that the painted and plated surfaces be polished with automobile wax. Once this has been done a periodic wipedown with a dry cloth will be sufficient.

Lubrication

Every sixty to ninety days, apply a light machine oil to the cabinet casters so they will roll freely.

Test Lead Maintenance

The test leads and power cord will retain their new appearance if they are cleaned periodically with waterless hand cleaner and wiped dry.

Calibration

To select the CALIBRATION MENU (Figure 64), return to the original PROGRAM MENU and select the fourth option.

POWER- The POWER light indicates that the AC switch (Figure 54) is On and the printer is powered-up.

The printer also has integral factory-set switches that must not be altered or re-set in any way. The rear cover of the printer should **not** be removed.

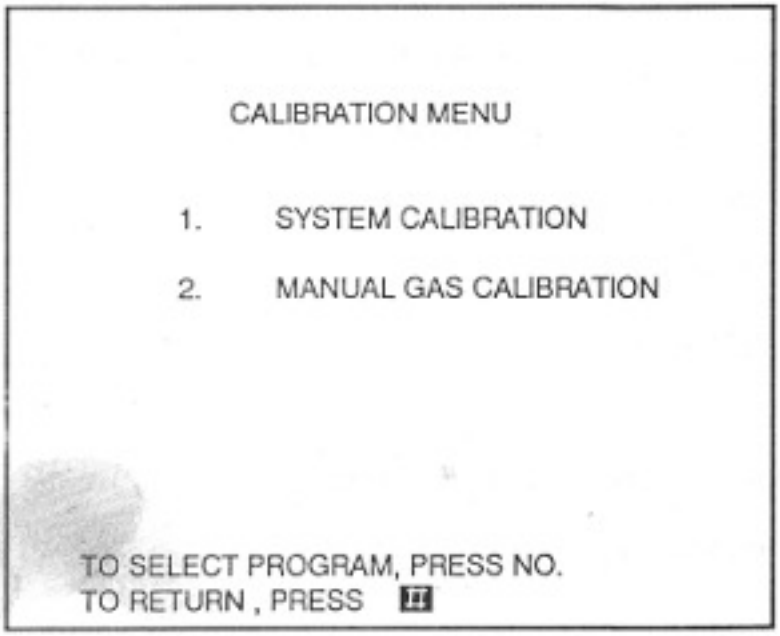


FIGURE 64. Calibration menu. (Emissions).

NOTE: The CALIBRATION MENU is available only when the emissions option is installed.

Selection #1: System Calibration

This page (Figure 65) is identical to the general test calibration page which appears automatically after the self-test/warm-up page upon system power-up.
It allows the analyzer to be re-calibrated without having to turn the unit off and perform self-test/warm-up procedures over again.

"NOT CALIBRATED" appears on emissions (HC, CO, CO_2 and O_2) if the tester is not fully warmed up. If "NOT CALIBRATED" appears, return to the calibration menu and perform calibration when "WARM-UP COMPLETE" appears on the menu page with the prompt to proceed.

If "SERVICE REQUIRED" appears on the VDU, remove all connections from the engine and repeat the calibration.

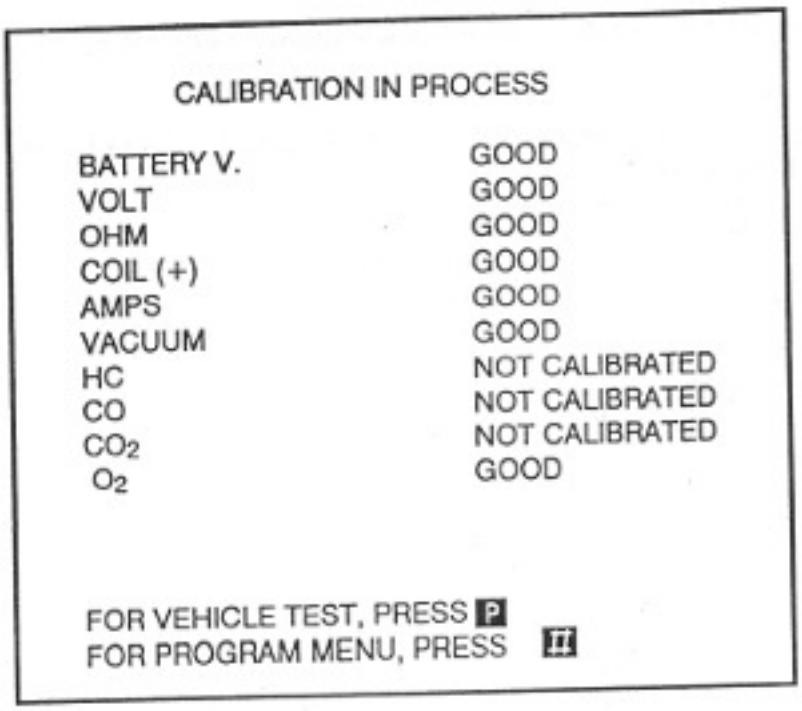


FIGURE 65. Calibration page.

Selection #2: Manual Gas Calibration

This selection is used to verify the accuracy of the analyzer's HC, CO, CO_2 and O_2 measurements. A bottle with a certified gas mixture is required to perform the calibration. This chapter is primarily intended for Sun Service Engineers.

NOTE: For some countries there are special rules for approved exhaust analyzers which need to be checked periodically with certified gas mixture.

However the LEAK CHECK can easily be done by the Operator. Just select #4 "LEAK CHECK" and follow the instructions on the VDU screen (Figure 66). Perform the leak check to verify that the exhaust sampling system of the gas analyzer is air-tight and free of leaks.

The message "LEAK CHECK PASSED" indicates that the system is air-tight. If the message "LEAK CHECK FAILED" appears, the system has a leak. In that case check the probe, hose, connections, or filters for leaks prior to repeating the test.

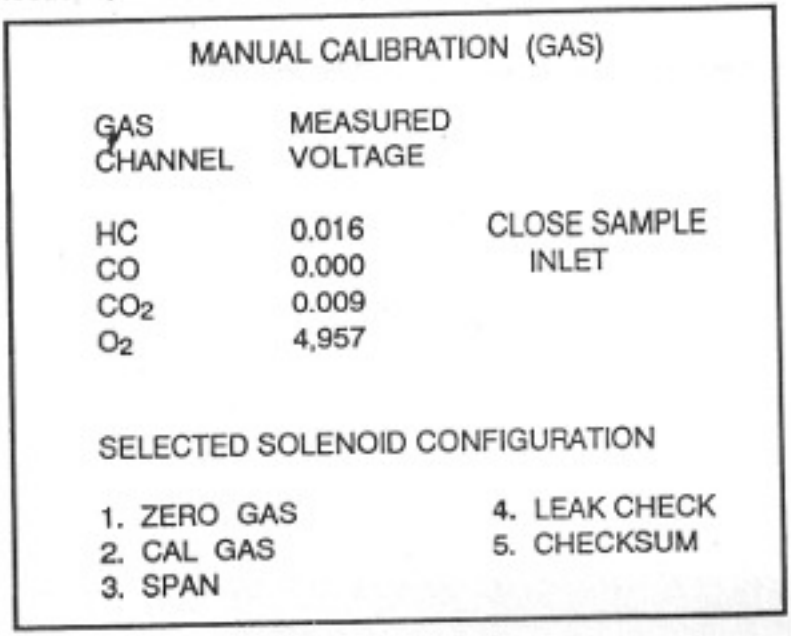


FIGURE 66. Leak Check Message.

Normal readings for #1 ZERO GAS, #2 CAL GAS and #3 SPAN are shown in Figures 67,68 and 69, using clean air as sample.
O_2 will always read high, up to 5 Volts.
HC,CO and CO_2 will read low, close to 0 Volts when ZERO GAS or CAL GAS is selected, and high, close to 5 Volts when SPAN is selected.

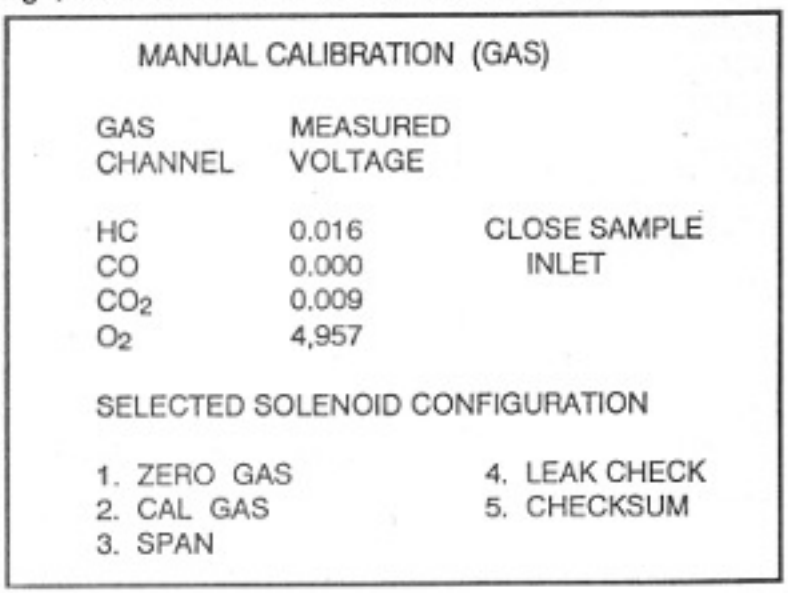


Figure 67. Zero Gas

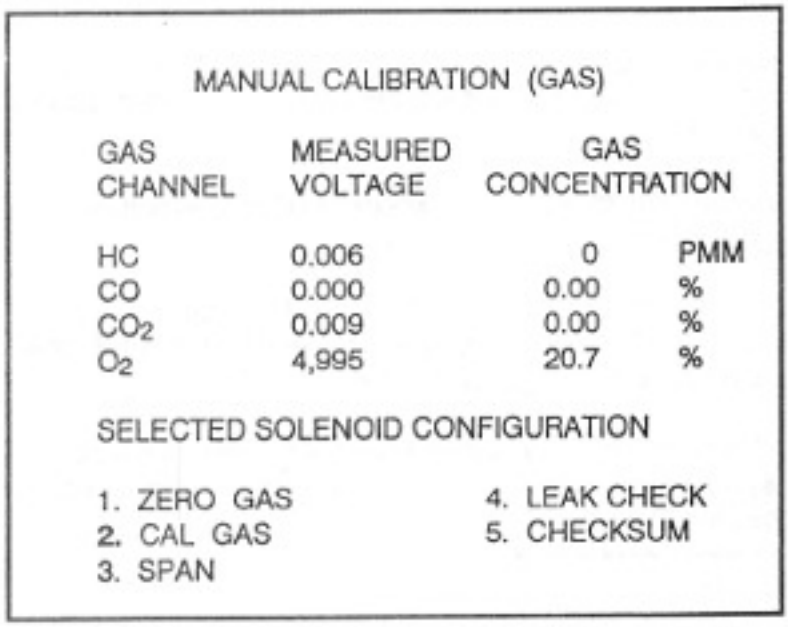


Figure 68. Cal Gas

MANUAL CALIBRATION (GAS)

GAS CHANNEL	MEASURED VOLTAGE
HC	4.796
CO	5.002
CO_2	4.988
O_2	4,998

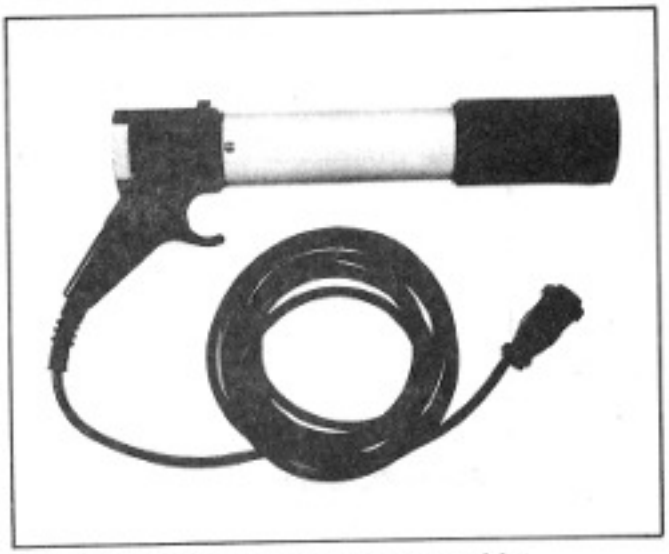
SELECTED SOLENOID CONFIGURATION

1. ZERO GAS
2. CAL GAS
3. SPAN
4. LEAK CHECK
5. CHECKSUM

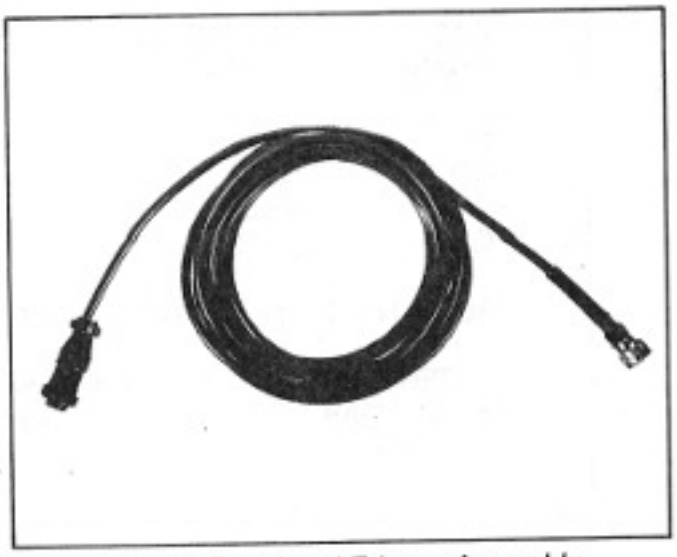
Figure 69. Span

STANDARD AND OPTIONAL ACCESSORIES

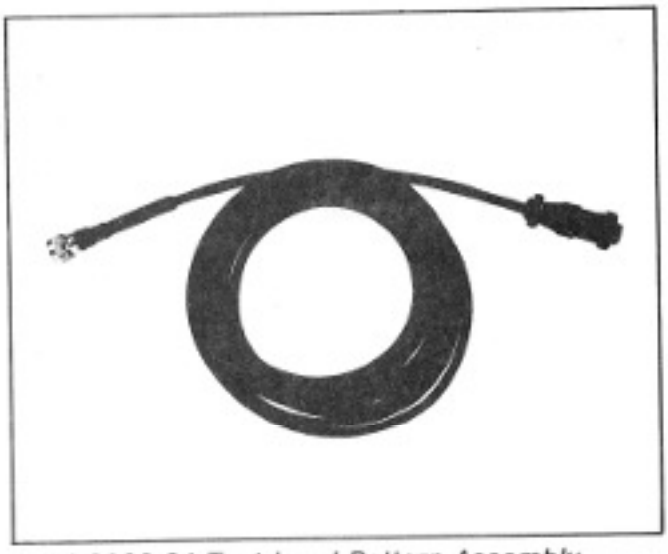
STANDARD



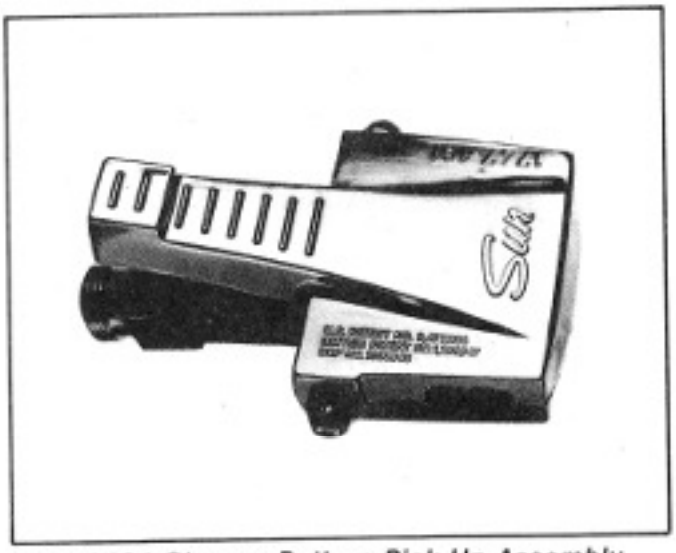
7009E9313-47 Timing Light Assembly



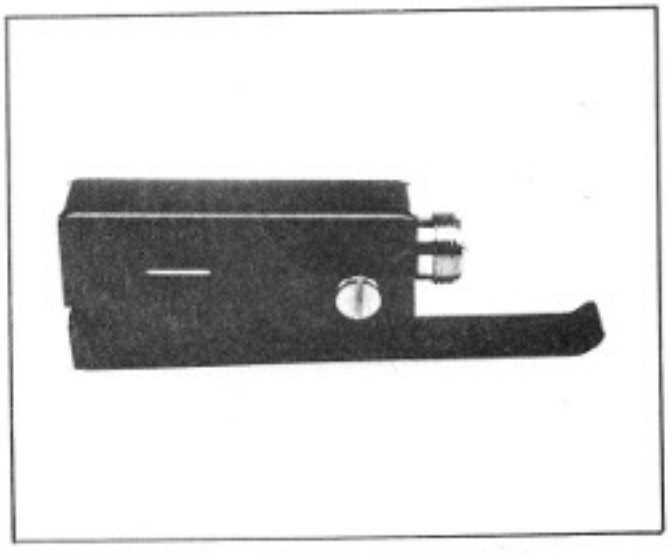
6004-0262-03 Test Lead Trigger Assembly



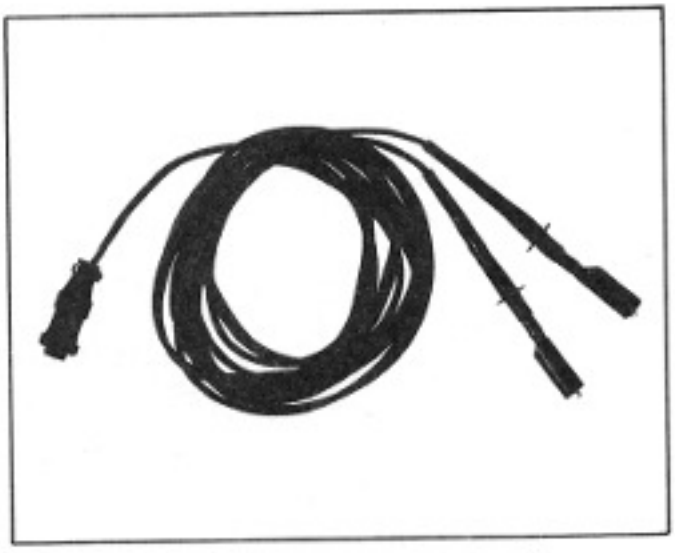
6004-0332-01 Test Lead Pattern Assembly



1747-0101 Chrome Pattern Pick-Up Assembly

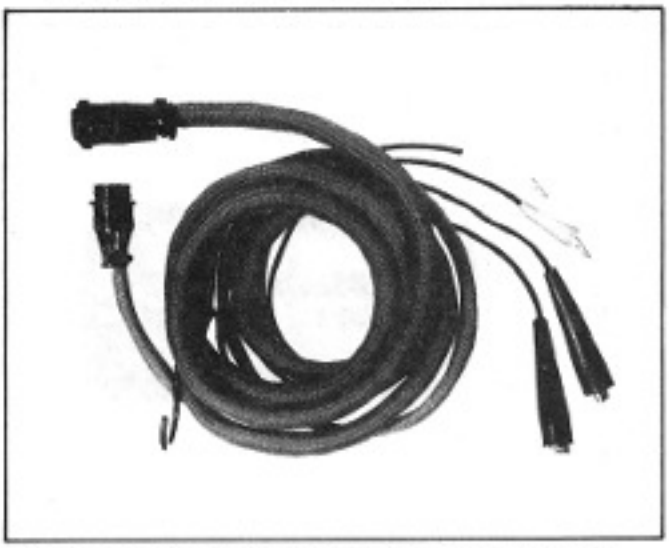


0507-0006 Trigger Pick-Up Assembly

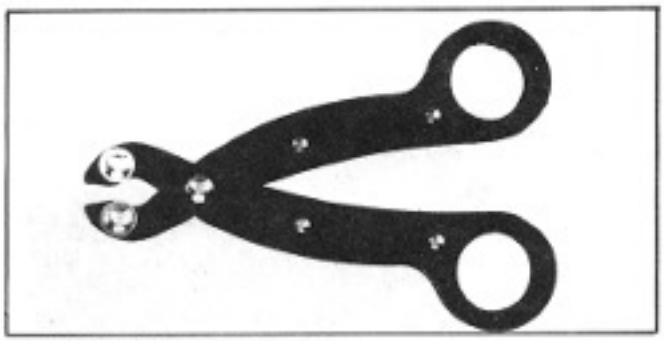


6004-0462 Test Lead Assembly, Volt Ohm

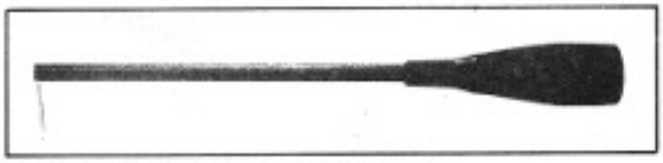
STANDARD (continued)



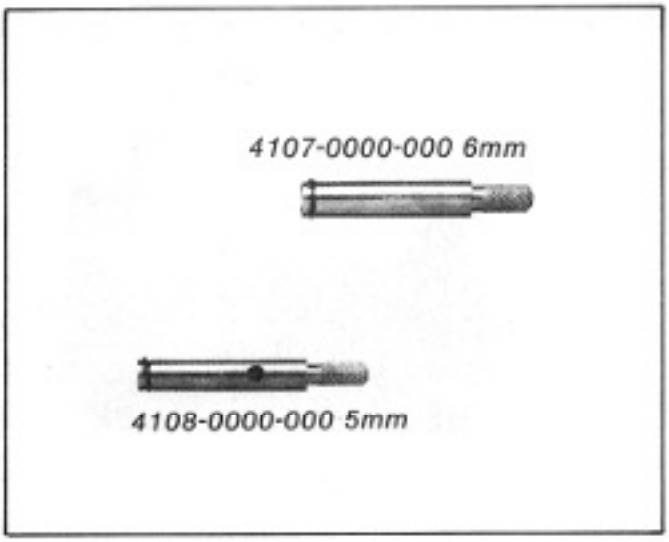
6004E9310-32 Universal Test Lead Assembly



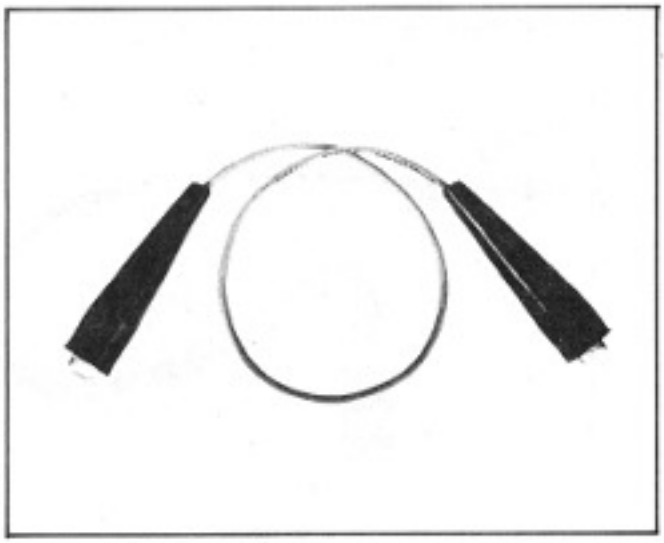
0002-1028 Insulating Pliers



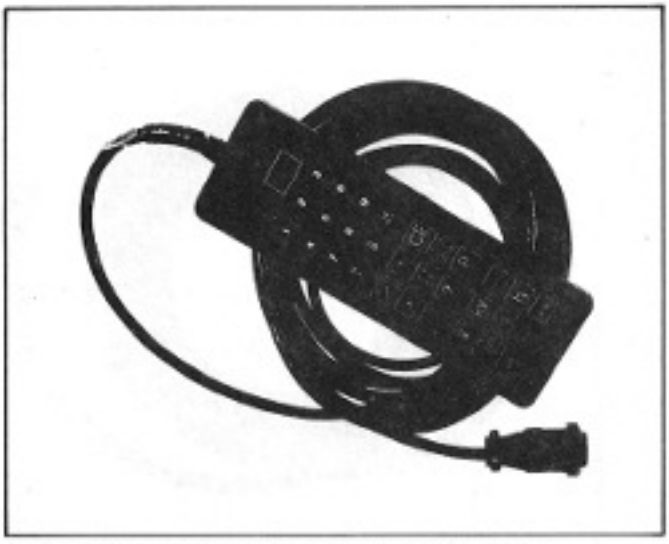
4344-0000 Resistance Test Probe



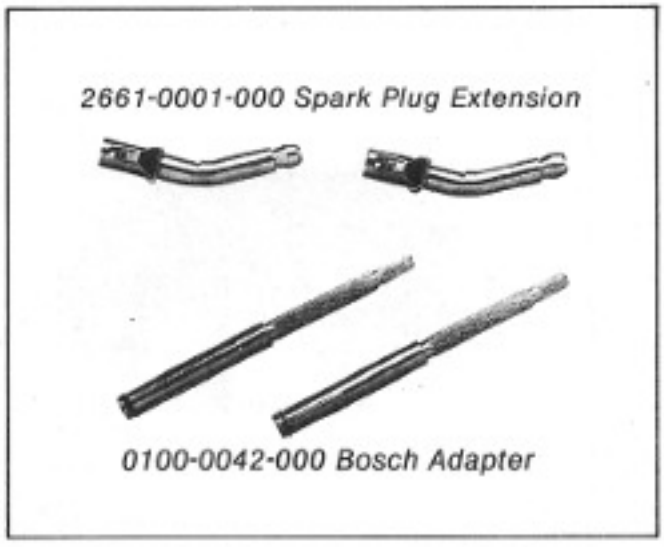
Ignition Coil Terminal Adapters



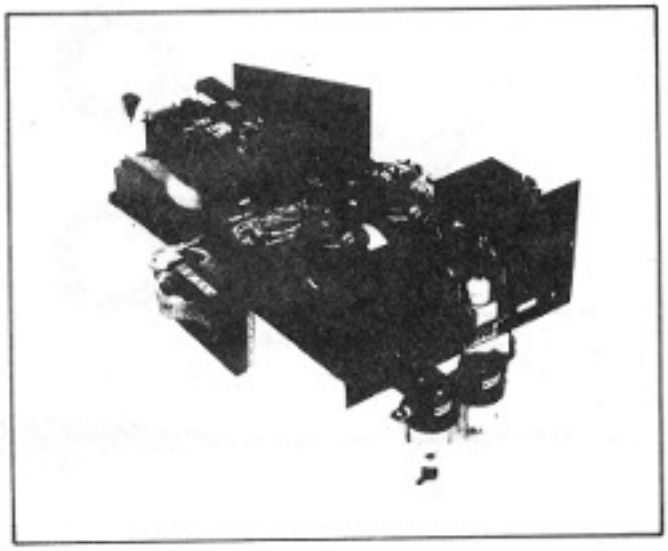
0002-0133-15 Lead



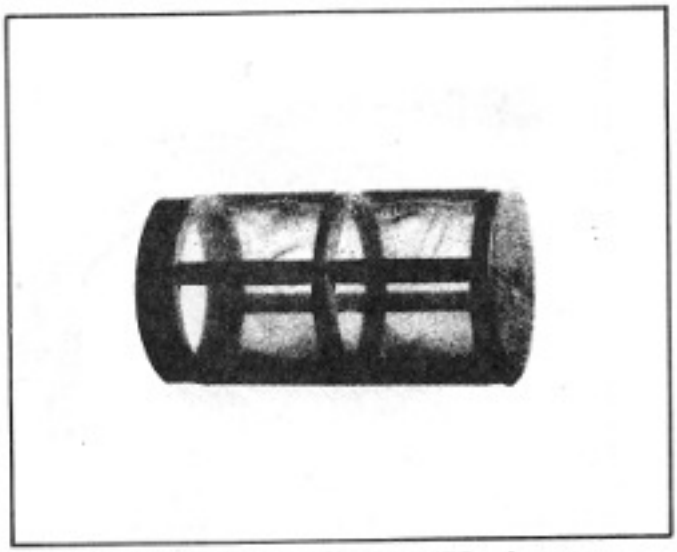
7009-1892-02 Remote Control Assembly



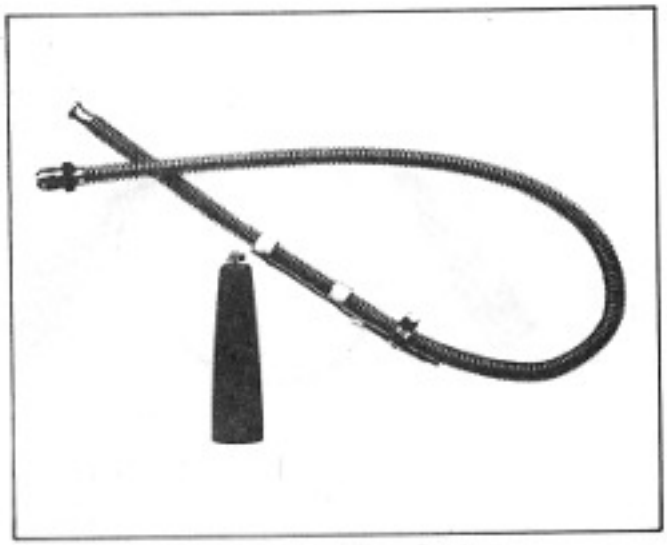
OPTIONAL 4-Gas Option Includes:



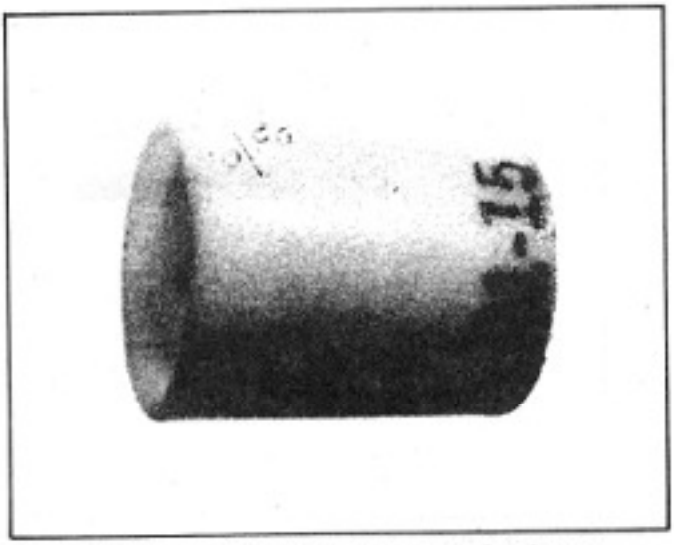
4-Gas Option



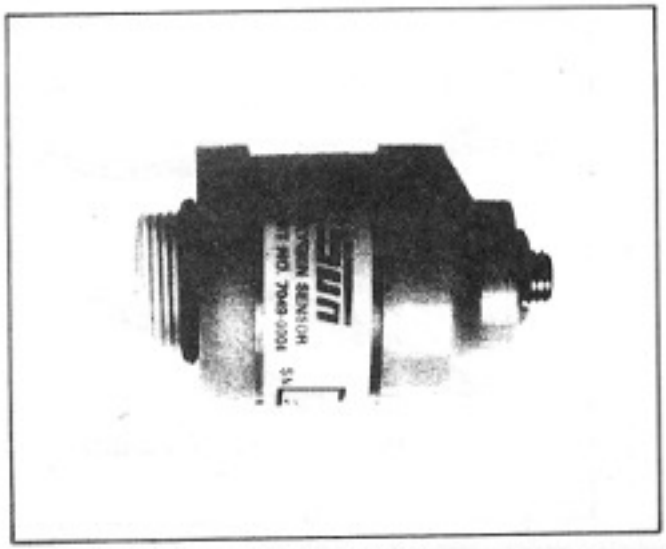
301-926 Primary Filter Element, 75 micron



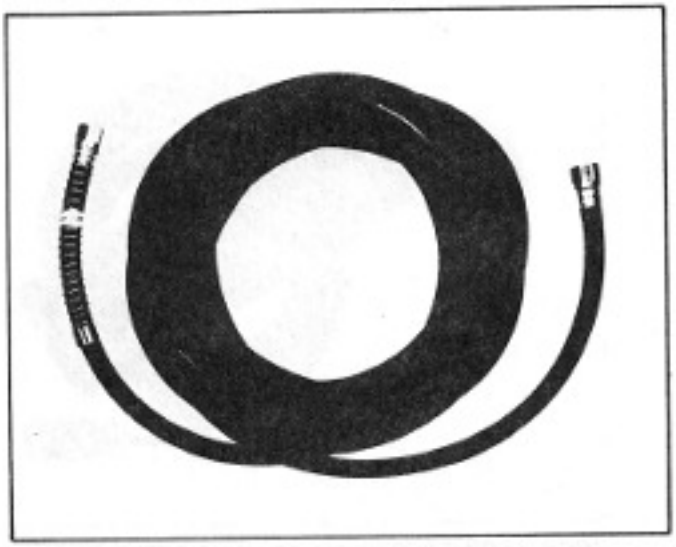
7009-0511 Exhaust Sampling Probe



301-908 Secondary Filter Element, 8 micron

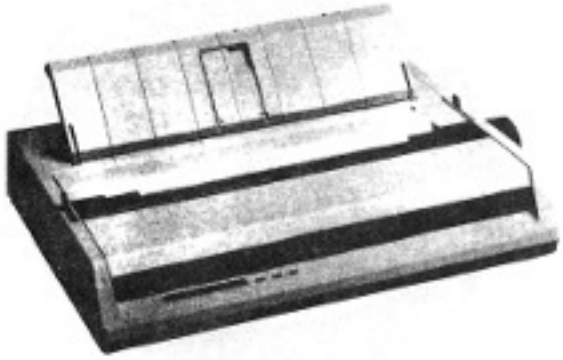


7049-0004 Oxygen Sensor Cell



3988-0202 Exhaust Sample Hose

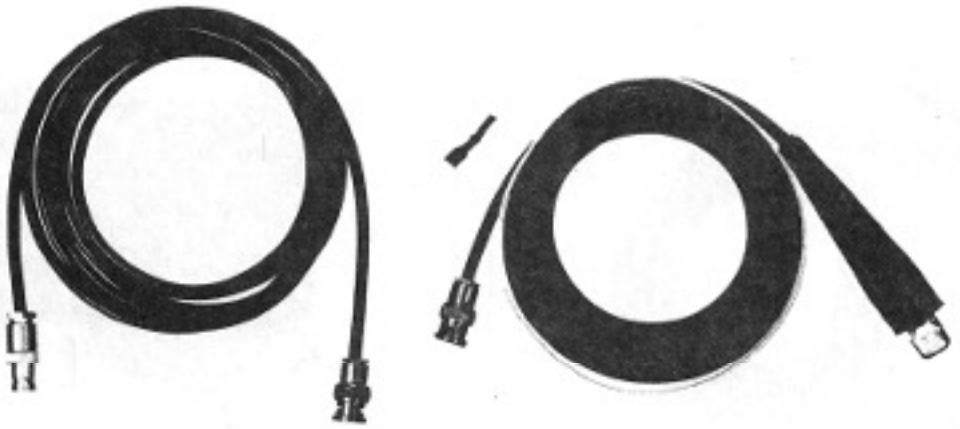
OPTIONAL (continued)



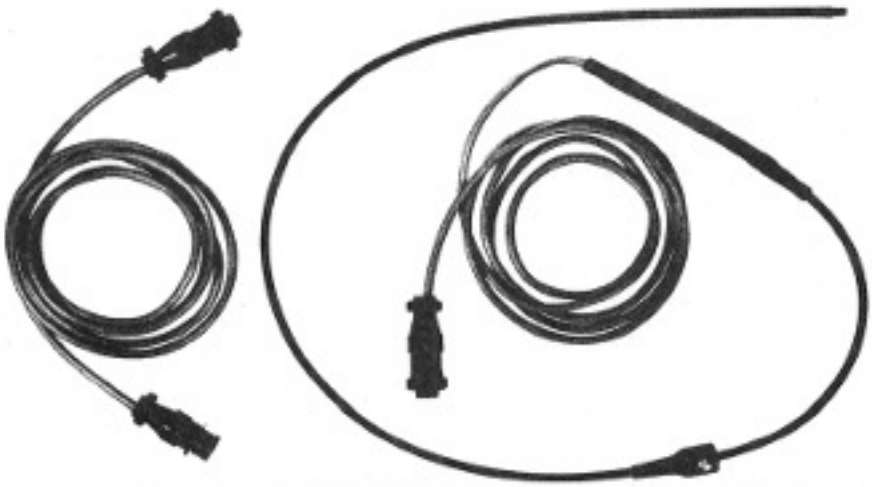
0528-0994 Printer Paper (not shown)

0528-0995 Ribbon Cartridge (not shown)

Printer AP 1000-1 (220/240 V) Incl. cover 7009E9313-44



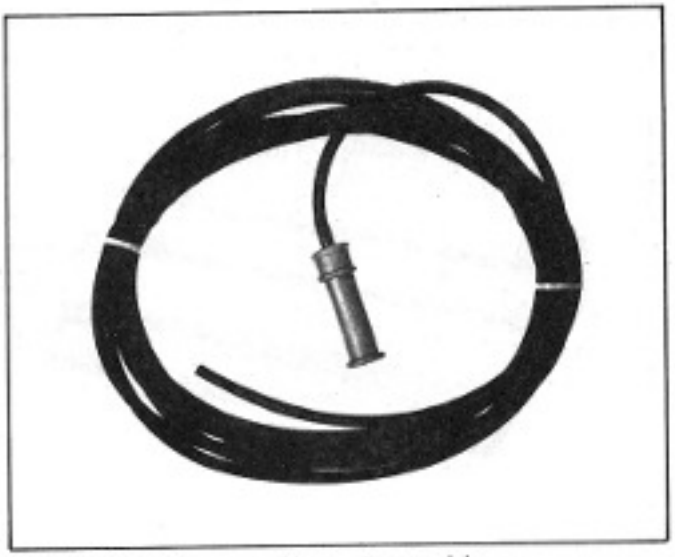
UNIVERSAL DIESEL KIT UDK-1 7009E9312-96 Includes:
0008-0472 Transducer, Clamp-on *003-2000-578 Lead for Transducer*



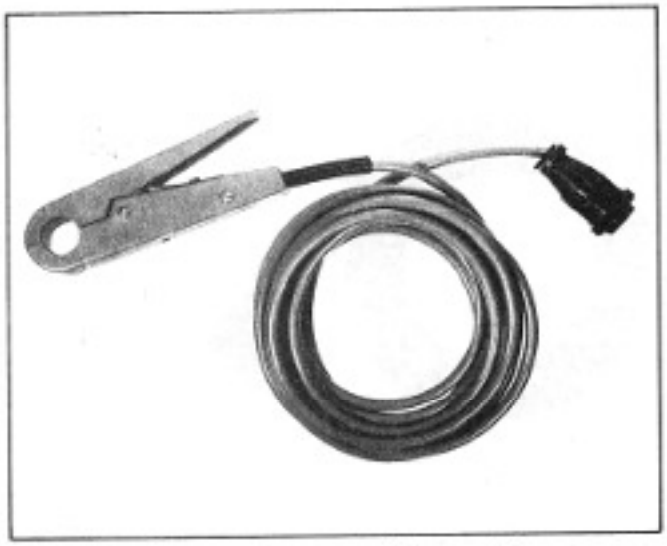
OIL TEMPERATURE KIT 7009E9314-21 Includes:
6004E9310 Oil Temperature Probe *6004E9310-42 Extension Lead for Oil Temp. Probe*

OPTIONAL (continued)

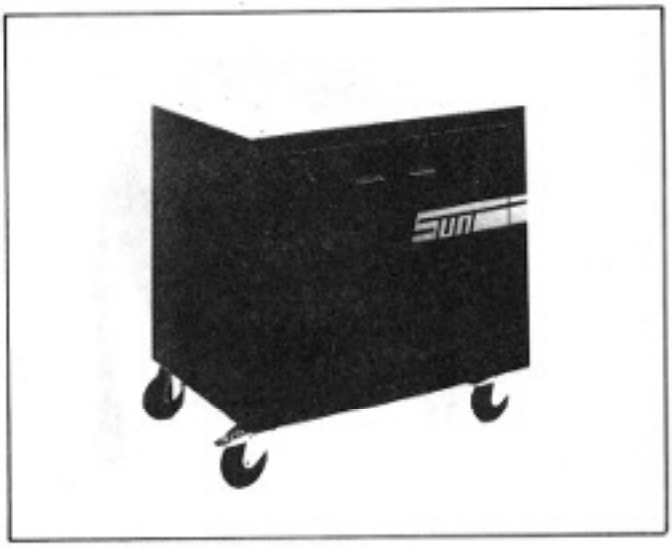
0120E0495 Amps/Vac Kit



6006-0007 Vacuum Hose Assembly

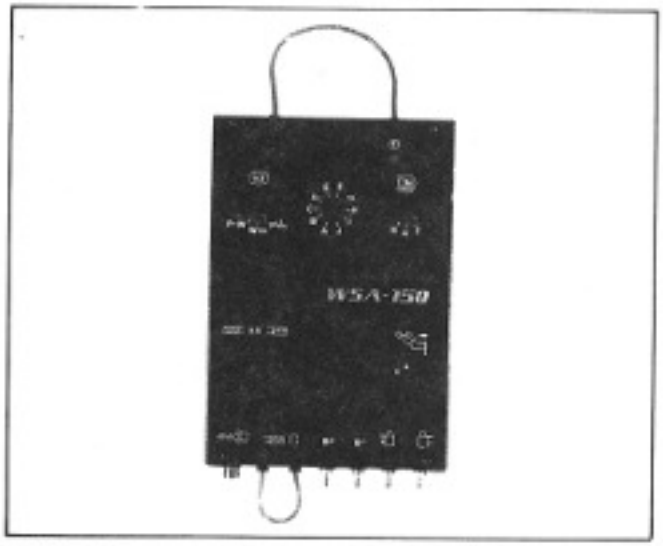


6005-0133-01 Ammeter Lead Assembly

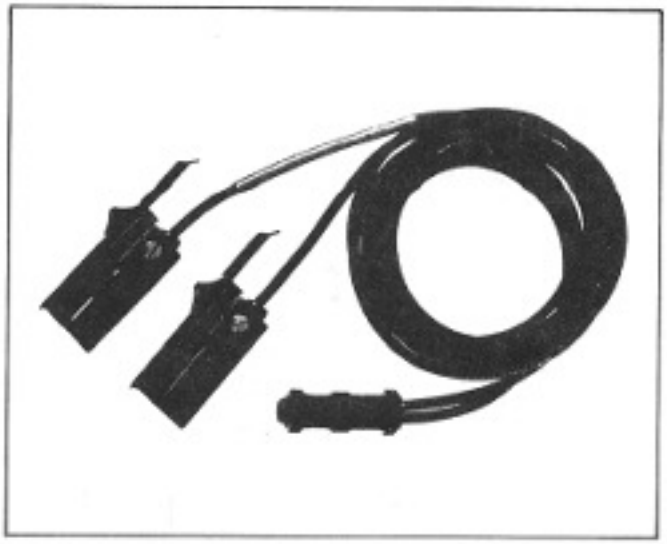


C-34 Test Cabinet

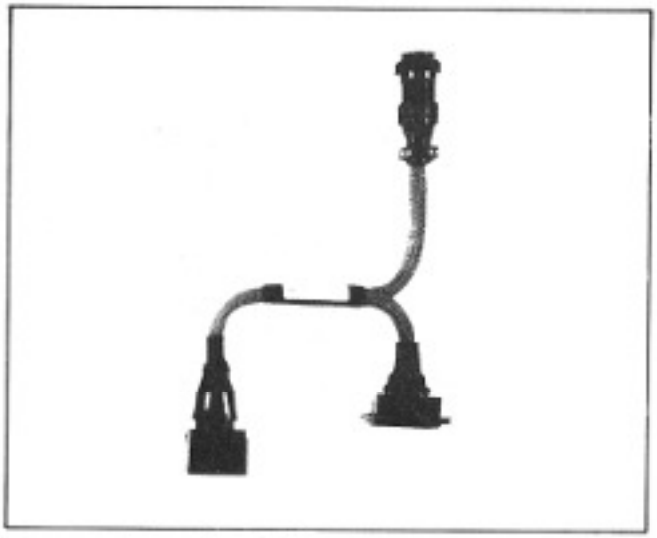
OPTIONAL (continued)



WSA -150



6004E9310-48 Pattern Pick-up for WSA



6004E9310-46 Ford Adaptor 4 Cylinder for WSA
6004-9310-49 Mitsubishi Adaptor for WSA
6004-9310-53 Toyota Adaptor for WSA
6004-9310-54 Universal Adaptor for WSA

NOTE: Various timing probes and diagnostic harnesses are available for the MEA-1500 SL ask your local Sun representative.

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